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BY H. K. FRY

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A more closely reasoned basis for the development of this system and for the origin of the Class Systems is presented.

Miss McConnel's data concerning the Wikmunkan system are used to explain the elaborate kinship terminology and the unusual class terminology of the Murngin tribe.

A genealogical interpretation of Miss McConnel's data concerning the Yaraidyana and Nggamiti tribes is submitted, and the conclusion reached that these systems are entirely anomalous and not prototypes in the development of the social organisation of Australian tribes in general.

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Eight members of an Adelaide University Expedition visited Hermannsburg in 1929. The Western Aranda people there allocated each member of the group to one of the eight named subclasses (subsections) of their tribe.

Our newly-acquired mutual kinships were difficult to comprehend, and I hit upon an arrangement of the subclass names in the following pattern where son is charted below father and daughter below mother:

PANANKA	pananka	PURULA	purula	KNURAI	knuraia	NGALA	ngala
BANGATA	kamara	KAMARA	bangata	PALTARA	mbitjana	MBITJANA	paltara
PANANKA	knuraia	PURULA	ngala	KNURAI	pananka	NGALA	purula
BANGATA	mbitjana	KAMARA	paltara	PALTARA	kamara	MBITJANA	bangata
PANANKA	pananka	PURULA	purula	KNURAI	knuraia	NGALA	ngala

The subclass names in capitals represent male members, those in small case female members. I adopted the converse representation originally, but changed to the above to conform to the generally accepted convention.

It was then realised that this genealogical pattern could be reproduced in a generalised form using eight symbols of an algebraical character representing the four subclasses of each of two moieties A and B. The symbols adopted at first were these moiety letters, numbers, and asterisks. The numbers and asterisks proved to be inconvenient and the convention adopted was a numeral prefixed to the moiety letter to distinguish alternate generations and a post-fixed numeral to distinguish subclasses of each generation.

The Aranda pattern can therefore be expressed in generalised symbols as follows:

1A1	1a1	1B1	1b1	1A2	1a2	1B2	1b2
2A1	2a1	2B1	2b1	2A2	2a2	2B2	2b2
1A1	1a2	1B1	1b2	1A2	1a1	1B2	1b1
2A1	2b2	2B1	2a2	2A2	2b1	2B2	2a1
1A1	1a1	1B1	1b1	1A2	1a2	1B2	1b2

The pattern is simplified if the prefixed numeral be placed at the beginning of each line and is taken to apply to each symbol of that generation.

If any two symbols representing brother and sister, e.g. 1A1 and 1a1 in the third generation line, be taken as *Ego*, man-speaking and woman-speaking respectively, all the genealogical interpretations of each Aranda kinship term can

be followed on the pattern and each kinship term will be located on the pattern in constant association with one symbol. This is a simple demonstration of the fact that subclass terminology is merely a variant form of kinship terminology with the great advantage that the subclass term is a constant in regard to each individual, whereas the kinship term is variable in its application, being related to a variety of *Egos*.

Following out the genealogical interpretation of kinship terms is simple as brother and sister are the same symbol in different case lettering in one horizontal line; father and mother are vertically above brother and sister respectively and are also husband and wife in that generation line.

The vertical lines of male descent represent clans. The Aranda pattern can be interpreted as the expression of a system of marriages between clans in accordance with the following diagram using the symbol = to represent marriage:

1A1=1b1	1B1=1a1	1A2=1b2	1B2=1a2
2A1=2b2	2B1=2a2	2A2=2b1	2B2=2a1

The same system of marriages can also be represented in particular reference to marriages of brother and sister as follows:

1A1-1b1	1A2=1b2	2A1=2b2	2A2=2b1
1a1-1B1	1a2=1B2	2a1=2B2	2a2=2B1

By postulating a hypothetical diagram of marriages the corresponding genealogical pattern can be constructed. The moiety symbol of son and daughter will follow that of the father in a patrilineal society, that of the mother in a matrilineal society.

I have spent many hours since 1929 experimenting with genealogical patterns constructed in this way, and plotting on these patterns the kinship terminologies of the various tribes. When the genealogical interpretations of the kinship terms of a tribe fall into consistent association with the symbols of a certain pattern, I have presumed that one has a realistic representation of some factual groupings in that society. Conversely, when the kinship terms of a tribe will not conform reasonably well with any genealogical pattern expressing a certain marriage rule, I have considered that the marriage rule in question is not a dominant factor in the marriage customs of that society.

These studies have led me to the conclusion (Fry, 1950) that the marriage system customary in a tribe of eight subclass divisions was also customary in the great majority of Australian tribes, both patrilineal and matrilineal, and whether named class divisions or even moieties were recognised or not.

This uniformity is understandable in view of the homogeneous nature of aboriginal societies, whether patrilineal or matrilineal, presumably for thousands of years. These societies were basically patriarchal family groups of hunters and food-gatherers. Each family group had its own definite home territory, but had widespread associations with other groups. Totemic ceremonies provided the most important of these contacts, others were walk-about, hostile forays, and trade. Every known person was a kinsman or kinswoman, unidentifiable strangers were killed. Uniform social stresses in such societies tended to establish customary intermarriages between certain groups, and consequently kinships tended to conform to a more or less uniform pattern. The development of such a pattern is analogous to the growth of crystals under uniform conditions of intermolecular and environmental stresses.

The stresses which have determined the dominant type of marriage interrelations and kinship terminology in Australia are considered to be founded in the general principle that the existence of human societies depends upon the elimination or mitigation of the disrupting influence of individualistic drives of which sexual competition is the most potent.

The following analysis of these stresses is suggested:

(1) Elimination of sexual competition within the family group is a first necessity, hence the custom of exogamy. Many theories have been advanced to explain the almost universal horror of incest in human societies. This appears to be the most realistic one.

(2) Totemism appears in Australia to have been the basis of the extension of the incest prohibition to include the totemic clan, and, by identifying parallel cousins with brother and sister, to have made marriage between cross-cousins the proper custom.

(3) The undesirability of sexual competition between father and son represents a strong tendency to make women of the son's generation ineligible to the father, and *vice versa*.

(4) The custom of taboo against the mother-in-law debar the son-in-law from her camp fire. If the established custom should be bilateral marriages between first cousins in a society where every known person is akin, very many women would have the status of mother-in-law. The social stress therefore is for marriages to be between cross-cousins "not too close up", who therefore may be classified as "second" cousins under a kinship term other than that applied to "first" cousins.

As will be discussed later, the main variant from the dominant type of marriage and kinship occurs in Northern Australia where marriage with a unilateral first-cousin is the rule. Greater dilution of the mother-in-law problem is attained there by requiring the potential wives to be of junior status.

(5) The most satisfactory solution of the practice of exogamy is the amicable exchange of women between groups. The normal system in Australia was the exchange of "sisters" between groups of opposite moiety, and exchange of women by men of the same moiety resulting in marriages with women of the grandchildren's generation. In patrilineal societies the latter type of marriage was arranged by exchange of "sister's daughters", so that one partner in the exchange married his sister's daughter's husband's sister's daughter (Radcliffe-Brown, 1930). In matrilineal societies the wife of the junior generation had the status of "daughter's daughter" (Howitt, 1904a). This could be the result of two men exchanging "daughters". The dominant genealogical pattern of kinships is asymmetrical in regard to lines of male and female descent. In both types of society if Ego be IAI wives of both generations will be Ibl, so conforming to the dominant genealogical pattern (Fry, 1934).

Where patrilineal and matrilineal societies are contiguous and their members intermarry, a simpler type of kinship terminology tends to appear as a compromise between the two asymmetrical versions of the genealogical pattern (Fry, 1934).

The dominant type of marriage custom and kinship social structure throughout Australia is considered to be a purely natural consequence of the operation of the above factors. A consciously motivated systematisation of the kinship groupings resulting from the genealogical pattern determined by these factors is considered to be responsible for the appearance of named moieties, of four named classes, and of eight named subclasses in certain tribes. An analogy is suggested between the mental processes underlying this systematisation of kinships and the systematisation of speech into grammatical forms.

It is because of this achievement of classification that I consider the older terms *class* and *subclass* preferable to the terms *section* and *subsection*. The latter terms were introduced by R. H. Matthews (1897) and at present are generally adopted. The fact that the term *class* has other meanings in other societies is no more a reason for seeking another term than is a possibly similar objection to the use of the term *class* in regard to a school population.

The tempting hypothesis that existing Australian societies represent stages in evolution from first-cousin marriages systematised in four named classes to

second-cousin marriages systematised in eight named subclasses is not credible. For example, the identity of procedure in arranging betrothals in matrilineal four-class societies in New South Wales (Matthews and Everitt, 1900) and in the patrilineal eight-subclass societies of Central Australia is typical.

That totemism has played an important part in moulding the Australian kinship systems is supported by the practice of the matrilineal tribes of New South Wales. Their normal marriage rules conformed to four class divisions, but marriages between totemic clans of one and the same class were also permissible. T. G. H. Strehlow (1947) has established that the clan in Central Australian tribes, in spite of conceptual totemism, is still a totemic clan. In sharp contrast to this view is Malinowski's article on Kinship in the *Encyclopaedia Britannica* 1929. Schoolcraft (1853) writing of the North American Indians stated "where there is a lapse of memory or tradition, the totem is confidently appealed to as the test of blood affinities, however remote". The same is true of the Australian aborigines.

Irregular marriages of certain types are always permissible in Australian societies. The consequent difficulties in kinship terminology are overcome simply by a readjustment of kinship terms. This I believe was first recorded by Howitt (1904b). The mental attitude involved is well illustrated by the aboriginal who had been baptised and given a Christian name. When the priest reproved him for eating beef on Friday, he protested that it was all in order as he had sprinkled water on the beef and called it fish.

The most important variation from the dominant type of social pattern occurs in certain tribes of Arnhem Land and Cape York Peninsula. Marriage with a woman who is a mother's brother's daughter but not a father's sister's daughter is the rule. The simplest genealogical pattern which will express this custom in a society with moiety divisions is one based on a diagram of marriages such as $A1-b2$ $B2-a2$ $A2-b1$ $B1-a1$ in all generations.

The corresponding genealogical pattern is as follows:

A1	a1	B1	b1	A2	a2	B2	b2
A1	b1	B1	a2	A2	b2	B2	a1
A1	a2	B1	b2	A2	a1	B2	b1
A1	b2	B1	a1	A2	b1	B2	a2
A1	a1	B1	b1	A2	a2	B2	b2

Warner (1930) has recorded the Murngin kinship terminology which is of this type, and it is not a simple one. I have shown (Fry, 1950) that a genealogical pattern based on a marriage diagram of

$$A1-b2 \quad B2-a2 \quad A2-b3 \quad B3-a3 \quad A3-b4 \quad B4-a4 \quad A4-b1 \quad B1-a1$$

is necessary to meet the demands of this complex terminology. There are also eight named classes, two in each generation for four consecutive generations.

The reasons for this complexity are apparently the demands of junior and senior status considerations as will be discussed under the Wikmunkan system.

Miss McConnell has carried out detailed investigations of the social structure of the tribes of Cape York Peninsula where considerations of senior and junior status are major factors in marriage and kinship. She has recently published a summary of her researches (McConnell, 1950).

The Wikmunkan (b) system which she has described is founded on the rule that a man marries his mother's younger brother's daughter, a woman her father's older sister's son. The rule therefore debar a man from marrying his father's sister's daughter as she is of senior status.

The apparent simplicity of this new principle is delusive. Age grades in a society are definite distinctions, the status of each individual being recognised uniformly by all the members of the community. The distinctions of senior and junior status are, however, indefinite, being based on the dependent variables of the relative ages of the individuals whose status is under comparison.

The Wikmunkan have kinship terms distinguishing senior and junior status for kindred of their own, their father's, and their children's generations, with the exception of father's sisters. The kinship terms of other generations are undifferentiated. There are three general principles governing the determination of relative seniority.

(1) Marriages with the mother's younger brother's daughter and the latter's younger sisters (the junior sororate rule) determine that *wife* and *mother* signify junior status. Each time one of these relationships occurs in the genealogical interpretation of a kinship term, an augmentation of junior status is indicated. Conversely, *husband*, *sister*, and *daughter* are significant of an augmentation of senior status.

(2) Under the junior levirate rule a man inherits the wives and children of his deceased older brother. As *Ego* is a living person and passes to his father's younger brother's camp, father is ranked with father's younger brother. Conversely, as older brother's children pass to *Ego's* camp, *Ego's* children rank with those of older brother.

(3) Each step up in generation level signifies an increase in seniority, and *vice versa*.

The effects of these principles frequently are conflicting.

In the Wikmunkan system kindred of near and distant relationship are denoted by the same kinship term. Nevertheless, a distinction between near and distant kin is made on the basis of the relative seniority of certain recognised lines of descent. Miss McConnel in interpreting the Wikmunkan system has adopted the conventions of indicating a relationship which is relatively remote by enclosing the relationship designation in inverted commas, or by prefixing to the translation of the kinship term the qualification of "1/2" or "outside" appropriate to remoteness of blood relationship or locality. Accordingly, "father's older brother", "father's younger brother", "mother's older brother", and "mother's younger brother" are recognised as representatives of clans differentiated from one another and from the clans of father and mother's brother by virtue of the relative seniority of their lines of descent.

The Wikmunkan social organisation is therefore more complex than the kinship terminology suggests.

The following abbreviations will be employed in illustrating and discussing genealogical patterns in this paper:

f. father	h. brother	c.-m. cousin-mother
m. mother	sr. sister	(joking relationship)
s. son	h. husband	o. older
d. daughter	w. wife	y. younger

Terms enclosed in brackets refer to a female-speaking *Ego*.

The question now arises whether these Wikmunkan clans can be correlated with a conventional genealogical pattern of kinships. The simplest possible pattern which could meet the requirements is that given previously on page 4. The following result then appears

A1	a1	B1	b1	A2	a2	B2	b2
				M, M, B.	m, m.		
A1	b1	B1	a2	A2	b2	B2	a1
F.		"M.O.B."		"F.Y.B."	m.	M.B.	
A1	a2	B1	b2	A2	a1	B2	b1
EGO		S, B, B.	w.		sr.		"m.o.b.d."

This pattern finds no provision for the lines "F.O.B." and "M.Y.B." The pattern must therefore be extended by at least one more pair of symbols. The result is as follows:

A1	a1	B1	b1	A2	a2	B2	b2	A3	a3	B3	b3
				<i>M.M.B. m.m.</i>						<i>W.M.M.B. w.m.m.</i>	
A1	b1	B1	a3	A2	b2	B2	a1	A3	b3	B3	a2
<i>F.</i>	<i>"M.O.B."</i>		<i>"F.Y.B."</i>		<i>m.</i>	<i>M.B.</i>		<i>"F.O.B."</i>		<i>"M.Y.B."</i>	
											<i>w.m.</i>
A1	a3	B1	b3	A2	a1	B2	b1	A3	a2	B3	b2
<i>EGO</i>		<i>SR.H.</i>			<i>sr.</i>		<i>"m.o.b.d."</i>		<i>"m.o.B.D.H."</i>		<i>w.</i>

This pattern in which six genealogical lines are represented conforms with the six lines of descent which Miss McConnell has identified.

Referring back to the Murgin system, it will be remembered that the kinship terminology of that society demands a genealogical pattern in which yet another pair of symbols is included, A4 and B4. In that pattern A4 represents the line "F.O.B.", whose women marry men of the B4 line. The Murgin system therefore distinguishes a "M.O.B." line B4 which is senior to that of the sister's husband B1. The term *dumungur* of the B4 line is an augmentative of the kinship term *due* of the B1 line. Marriages of men of the A3 line are with women of the B4 line, and the A3 women marry men of the "M.Y.B." line B3.

The recognition of senior and junior status in addition to that of kinship provides a sufficient reason for the curiously complex Murgin kinship terminology.

The Wikmunkan kinship terms are charted on a genealogical pattern in Diagram I. It will be noted of the B3 clan that the men marry women of the senior line A3, and the women marry men of the junior line A2. A similar circumstance has been remarked upon in regard to the A3 clan in the Murgin system.

This apparent anomaly can now be explained.

Marriages between the Wikmunkan clans can be interpreted as a continuous cycle,

$$\begin{aligned}
 B2 &= a2 \\
 A1 &= b2 \quad A2 = b3 \\
 a1 &= B1 \quad a3 = B3 \\
 b1 &= A3
 \end{aligned}$$

B3 is at the opposite pole of the cycle to A1. If A1 be *Ego* as in Diagram I, B3 is the end member of a series of wife's brothers of progressively increasing junior status, and also the end member of a series of sister's husbands of progressively increasing senior status. In the Murgin system A3 occupies this position.

If *Ego* be selected as a representative of each clan in succession, other clans will be found to assume senior or junior status as follows:

<i>EGO</i>	<i>"F.O.B."</i>	<i>"F.Y.B."</i>	<i>"M.O.B."</i>	<i>M.B.</i>	<i>"M.Y.B."</i>
A1	A3	A2	B1	B2	B3
A2	A1	A3	B2	B3	B1
A3	A2	A1	B3	B1	B2
B1	B3	B2	A3	A1	A2
B2	B1	B3	A1	A2	A3
B3	B2	B1	A2	A3	A1

So the B3 men and women from their own standpoint marry normally, which, of course, one knows by the definition of the pattern, but which one can lose sight of in the complexity of the system.

But there is yet another complication. These clans do not have the stable identity of purely kinship clans. Being differentiated by assessments of relative seniority, new clans originate in the senior and junior branches of the clans in senior generations. These new clans must be assimilated in the social system in categories other than those of the clans from which they have stemmed.

Miss McConnell's only mention of an exchange marriage in the Wikmunkan system is that *Ego's* wife's father's father exchanges his son's daughter for *Ego's* "older sister". Following my diagrams, this means that a B2 man marries an

2.	A1 PINYA F.F.F.	b2 muka f.f.m.	B1	a1 pinya f.f.sr.	A2 PINYA M.M.F.	b3 muka m.m.m.	B2 MUKA F.F.M.B.	a2	A3	b1	B3 MUKA W.M.M.F.	a3 nengka w.m.m.m.
1.	A1 PULA F.F.	a1 kaml f.f.sr.	B1 NAITYA F.F.SR.H.	b1	A2 PULA M.M.B. "F.F.Y.B." W.M.F.	a2 pula m.m. m.m.y.sr. w.f.m.	B2 NAITYA F.M.B. M.F. W.F.F.	b2 naitya f.m. m.f.sr.	A3	a3	B3 NAITYA W.M.M.B. "M.F.Y.B."	b3 naitya w.m.m.
2.	A1 PINYA F.O.B. PIP F.	b1	B1 MUKA F.SR.H. SR.H.F. "M.O.B."	a3 pinya "f.o.sr."	A2 PIPA M.M.B.S. "F.Y.B."	b2 muka m.o.sr. kata m.	B2 MUKA M.O.B.	a1 pinya f.sr.	A3 PINYA "F.O.B."	b3 kata "f.g.b.w."	B3 KALA "M.Y.B."	a2 pinya "f.g.b.d." f.g.sr. w.m.
1.	A1 WUNYA O.B. EGO	a3 yapa "o.sr."	B1 MOIYA SR.H. "M.O.B.S."	b3 moya "m.y.b.d."	A2 PUNTA "Y.B."	a1 yapa o.sr. f.sr.s.w. f.sr.s.w.	B2 MOIYA M.O.B.S. KUT W.Y.B.	b1 moya f.sr.d. kata c-m.	A3 WUNYA "O.B." PINYA C-M.H.	a2 wila w.y.b.w. "y.sr."	B3 KUT "W.Y.B."	b2 moya m.o.b.d. o.b.w. w.o.sr. kut w. y.b.w. w.y.sr.
2.	A1 NENGKA O.B.S. Y.B.S. S.	b3 mukaiya "w.y.b.d."	B1 TUWA O.SR.S. Y.SR.S. D.H.	a2	A2 PINYAYA	b1 tuwa o.sr.d. y.sr.d.	B2 MUKAIYA W.Y.B.S.	a3 nengka c-m.d.	A3 NENGKA C-M.S. SR.D.H.	b2 mukaiya w.y.b.d. s.w.	B3 MUKAIYA "W.Y.B.S."	a1 pinyaya y.b.d. nengka d.
1.	A1 PULYA S.S.	a2 pulya	B1 NAITYA D.S. S.D.H.	b2 naitya w.b.s.d. s.s.w.	A2 PULYA	a3 pulya sr.d.d.	B2 NAITYA W.E.S.S.	b3 naitya "w.y.b.s.d."	A3 PULYA SR.D.S. D.D.H.	a1 pulya s.d. d.s.w.	B3 NAITYA	b1 naitya d.d. sr.s.d.
2.	A1 PIPA S.S.S.	b2 kata s.s.s.w.	B1 KALA D.S.S.	a1 pinyaya s.s.d.	A2 PIPA SR.D.D.D.H.	b3 kata sr.d.d.d.	B2	a2	A3 PIPA D.D.S.	b1 kata d.s.d.	B3 KALA D.D.D.H.	a3 pinyaya d.d.d.

DIAGRAM I.

Wikmunkan Kinship Terms charted on the genealogical pattern of the marriage diagram.

A1 = b2 B1 = a1 A2 = b3 B2 = a2 A3 = b1 B3 = a3 in all generations.

A3 woman belonging to his "M.Y.B." clan which is a deviation from the ordinary rule.

Miss McConnell considers that the marriage systems of the Wikmunkan and neighbouring tribes follow a downward spiral. I do not agree with this. The downward trend of junior marriages in any one generation is countered by the operation of the levirate rule under which women of senior status are taken in marriage. Also, her description of a downward spiral of marriages requires that only the most junior men in a generation marry women of a younger generation. That older men would surrender this privilege to their juniors would be a most unusual event in Australian societies. Her reasoning is based on her diagram which shows that men of the most junior line (corresponding to that of B3 in my Diagram I) marry women of a senior line (A3 in my diagram) in a lower generation. As has been shown above, a B3 man marrying a woman of an A3 line is marrying a woman of his mother's brother's clan, which is not a senior line. If, however, he marries a woman of that clan who is of his grandchildren's generation, she can be of senior status in that generation. This is surely the normal rule which all men are entitled to follow.

Wikmunkan kinship terms differentiate alternate generations. Diagram I therefore shows the generation lines numbered 1 and 2 alternately. However, the use of the terms *pinyawa* for husband's older brother, *kata kalana* for "m.o.b.d." and *pinya* for the latter's husband indicates a tendency to rank these kindred of senior status in Ego's generation with father and mother.

Class nomenclature, as stated previously, is a stabilised form of kinship terminology, the respective terms remaining constantly associated with each individual in the society. Aboriginal kinships implicate social functions of which marriage is the most important. Earlier authors therefore have described classes and subclasses as "marriage classes".

The systematisation of kinships by some tribes into eight subclasses representing alternate generations of four types of clans was a great achievement. The Murngin society incorporates eight types of clans, which are differentiated by a recognition of relative seniority status superimposed upon that of kinship. Such clans, as we have seen, cannot be represented by a stabilised kinship nomenclature. The Murngin named classes therefore distinguish only moieties in each generation.

Marriages between clans in accordance with the Murngin marriage diagram theoretically could be between men and women of any generation. The Murngin kinships differentiate alternate generations so that father and son do not compete for the same women. The Murngin class system reinforces this differentiation, and also provides the advantages of the stabilised kinship identifications of an eight-class system by the ingenious device of having named classes to represent the individuals of the two moieties in four successive generations.

N. W. Thomas (1906) ascribed the evolution of eight-class divisions to a distinction between older and younger sisters. Miss McConnell has suggested that the tribes of Cape York may represent relics of the original aboriginal immigration into Australia and that the junior marriage customs in that region may be prototypes of aboriginal systems of kinship and marriage. A close consideration of these Northern Queensland systems is therefore indicated.

The Wikmunkan (b) system has been discussed and is related to the Arnhem Land systems only. It appears to differ fundamentally from the dominant Australian system.

Miss McConnell has also described:

(1) A Wikmunkan (a) system of junior marriages with mother's brother's daughter or father's sister's daughter.

(2) A Kandyu system of marriage with father's sister's daughter not mother's brother's daughter.

(3) A Yaraidyana system of marriages with father's sister's daughter's daughter not mother's brother's daughter's daughter.

(4) A Nggamiti system of marriage with father's sister's daughter's daughter and mother's brother's daughter.

The Wikmunkan system (a) requires the co-existence of two apparently incompatible provisions, marriage with the mother's younger brother's daughter, or the father's sister's daughter. As wife's mother is normally a member of a "F.Y.B." clan, in other words she is a "father's younger sister", marriage with a father's sister's daughter "not close up" is a normal occurrence. A special emphasis on this paternal kinship could represent an approximation of the bilateral exchange of second cousins which is a feature of the dominant system of aboriginal marriage.

Miss McConnell has interpreted the Kandyu society as a system of junior marriages with a father's sister's daughter, mother's brother's daughter being *taboo*. This is the only instance of the operation of this marriage rule of which I am aware. Previously (1950) I have denied its existence. The genealogical pattern of such a system is based on a marriage diagram of the type:

$$\begin{array}{llll} 1A1-1b2 & 1B1=1a1 & 1A2-1b1 & 1B2=1a2 \\ 2A1-2b1 & 2B1=2a2 & 2A2-2b2 & 2B2=2a1 \end{array}$$

Kandyu kinship terms are plotted on such a pattern in Diagram II. A minor deviation from the pattern is that Miss McConnell identifies w.f.m. (a2) with f.f.y.sr. (a1) in her genealogical table on page 125. *Alma* is shared between A1 and A2 lines, but by description is a generalised term. Important points are that wife's mother may be *pima* f.y.sr., or *pinya* f.o.sr.; that wife's father may be *kala* f.m.y.b.s., m.m.y.sr.s., or $\frac{1}{2}$ m.y.b., or *muka* $\frac{1}{2}$ f.m.o.b.s., or $\frac{1}{2}$ m.m.o.sr.s.; that the daughter of *muka* and *pinya* cannot be married; that the daughter of *muka* and *pima* or of *kala* and *pinya* may be married, in which case kinship terms are adjusted to those of a proper marriage with the daughter of *kala* and *pima*. Therefore the *taboo* against the mother's brother's daughter only operates if she is "too close up", indicating a possible transition to second-cousin marriages. Contrasted with the Wikmunkan (b) system, the Kandyu has the important difference that father and son marry women from alternate groups, a characteristic of the marriages of the dominant system.

Miss McConnell has recorded that in a Kandyu exchange marriage *Ego* gives his *ngama* (m.b.d.) to his wife's *ngama* (her f.sr.s., and *Ego's* "o.b.") and in return his wife's brother gives his *ngama* (*Ego's* sr.) to his wife's *ngama* (*Ego's* m.b.s.). The same transaction would be accomplished if *Ego* gave his sister to his m.b.s., who in return gave his sister to *Ego's* "older brother". Miss McConnell (1952) has suggested this right of a man to dispose of his m.b.d. in marriage may be a survival from a time when he had the right to marry her himself. Miss McConnell also records exchange marriages where the senior partner apparently marries his wife's brother's son's son's daughter, a woman of the third lower generation.

This marrying outside a man's own generation or that of his grandchildren is described by Miss McConnell as a characteristic feature of the Yaraidyana and Nggamiti societies who have the custom of marriage with the father's sister's daughter's daughter. These tribes are stated to be patrilineal. The Ungarinyin (Elkin, 1932) and the Wornra (Love, 1950) in the Kimberley district of W.A. have the custom of marrying the sister and daughter of a man of their own generation. This custom in a patrilineal society at least assures that the wives are of the right moiety. Father's sister's daughter's daughter in a patrilineal society with moiety divisions must belong to the same moiety as the man speaking. A matrilineal system would retain the daughter in the same moiety as her mother, but the marriage rule in question in a matrilineal society is not

1A1 PIPA F.P. M.M.B. W.M.F.	1a1 mimi f.f.sr. m.m.	1B1 AITYI M.F.	1b1 aityi m.f.sr.	1A2 PULA F.O.B. ALNA M.F.S.R.H.	1a2 mimi w.f.m.	1B2 AITYI F.M.B. W.F.F.	1b2 aityi f.m. u.m.m.
2A1 PIPA F.	2b1 bapa m.	2B1 MUKA M.O.B. M.M.O.S.R.S. W.F. KALA M.Y.B. M.Y.S.R.S. M.Y.B. W.F.	2a2	2A2 PINYA F.O.B. ALMA W.F.S.R.H.	2b2 muka bapa w.f.sr. w.f.sr. w.f.sr.	2B2 MUKA F.M.O.B.S. W.F. KALA F.M.Y.B.S. W.F.	2a1 pinya f.o.sr. m.y.b.w. u.m.
1A1 YAPO O.B. ALMA F.O.S.R.D.H. EGO man speaking	1a1 yaa o.sr. [ego] woman speaking	1B1 MOIVA M.O.B.S. S.R.H. [H.] PHILIPA M.Y.B.S. NGAMA M.Y.B.S.]	1b1 wulama [m.d.d.] ngama m.d.d. c.-m.	1A2 YAPO O.B. ALMA M.B.D.H.	1a2 yaa aima w.b.w. w.sr.	1B2 PHILIPA F.O.S.R.S. W.B. NGAMA [F.S.R.S.] [B.W.B.]	1b2 wulama f.y.sr.d. kulanta w.
2A1 PIATO O.B.S. Y.B.S.	2b1 mampa o.sr.d. y.sr.d. s.w.	2B1 MAMPA O.S.R.S. MUKAIYA Y.S.R.S.	2a2 piato o.b.d. y.sr. m.f.y.b.w.	2A2 PIATO O.B.S. ALMA W.B.D.H.	2b2 mampa w.b.d. f.f.y.b.w.	2B2 MAMPA D.H. MUKAIYA Y.B.D.H.	2a1 piato o.b.d. y.b.d.
1A1 PULATO S.S.	1a1 mimi e.d.	1B1 NAITYIYU S.R.S.S.	1b1 naitiyu s.r.s.d.	1A2 PULATO ALNA S.R.S.D.H.	1a2 pulato d.s.w. m.y.b.w.	1B2 NAITYIYU D.S.	1b2 naitiyu d.d. s.s.w.

DIAGRAM II.

Kandyu kinship terms charted on the Genealogical Pattern of the Marriage diagram.

1A1 = 1b2 1B1 = 1a1 1A2 = 1b1 1B2 = 1a2

2A1 = 2b1 2B1 = 2a2 2A2 = 2b2 2B2 = 2a1

Representing marriage with the father's sister's daughter, but not with mother's brother's daughter.

Terms enclosed in brackets refer to Ego woman speaking.

2A INATA F.F.F.	1a wuratha f.f.sr. m.m.m.	2b ukuta m.f.f.sr. f.f.m.	2c UKUTA M.F.F.	1b	2a inata f.f.sr.	"upandi" apitha m.f.sr.d. m.f.sr.d.	1c apitha m.m.f.sr. f.m. v.m.m.m. w.	2C AMITHA M.F.SR.H. M.M.F.F. F.M.F.
1A WURATHA F.F. V.M.M.F. UPUNGA M.F.SR.D.H	2c "inata" ulbu m.f.sr. m.f.sr.	1a wuratha f.f.sr.	1B ATITHA M.F.	1c	1b atitha m.f.sr. f.m.m.	inata f.o.sr. ayuwihin v.m.m.	2a inata f.f.sr. ayuwihin v.m.m.	1C "UPUNGA" APITHA M.F.SR.S. M.M.F. F.M.B. W.F.F.
2A INATA F.O.B. IBATHA F.	2b ukuta m.o.sr. inyungu m.	2c inyungu m.p.sr. inyungu m.	2B ARATHA M.Y.B. F.F.SR.H. W.M.F.	2a inata f.o.sr. f.f.sr.	1c	ameri f.o.sr.d. m.b.d.	1b ayuwih f.f.sr.d. v.m.	2C "IBATHA" AMITHA ULBU M.M.H. F.M.B.S. W.F.
1A UPUNGA O.B. EGO	upandi o.sr.	1a itainu p.sr.	1B AYUWIN M.O.B.S. M.Y.B.S. F.Y.SR.S. S.R.D.H. W.M.B.	1b	2a "itamu" pingara m.b.d. p.p.d.w.	1c manwara w.	1C "ITAMU" MAUWARA PINGARA M.B.D.S. SR.H.	
2A ANAIKI O.B.S. ANAIKI S.	2c ukuta p.sr.d. amigara f.sr.s.w.	1a wuruka s.d.	2B AMUKA SR.D.S. MINGARA D.H.	1c	1b amaki o.b.d.	2a inyuka p.b.d.	2C UKUKA Y.SR.S. D.D.H. W.B.S.	
1A WURUKA S.S.	2b amuka s.d.d. mingara s.w.	2c ukuta s.d.d. d.s.w.	1B ATUKA AYUWIN D.S.	2a	1c apuka s.s.w.	1b atuka d.d. m.b.s.s.d. ameri	1C APUKA PINGARA D.D.S. S.D.H.	
2A INUKA S.S.S.	1a wuruka s.d.	2b inyungu s.s.s.w.	2B AMUKA D.S.S.	1b	2a	1c apuka s.s.w. w.	2C UKUKA S.D.S.	

DIAGRAM III.

Yaraidyana Kinship Terms charted on the Genealogical Pattern of the Marriage diagram.

2A = 2b 2B = 2a 2C = 1b
1A = 1c 1B = 2c 1C = 1a

amenable to the dictates of moiety divisions. (Vide appendix.) Therefore, the Yaraidyana and Nggamiti societies cannot conform to moiety regulation.

A genealogical pattern which conforms with the Yaraidyana kinship terminology is based on the marriage diagram:

1A=1c	1B=2c	1C=1a
2A=2b	2B=2a	2C=1b

or, expressed in the form representing sister exchange,

1A=1c	1B=2c	2A=2b
1a=1C	1b=2C	2a=2B

This genealogical pattern takes the following remarkable form:

1A	1a	2b	2c	1B	1b	2a	1c	1C
2A	2c	1a	2b	2B	1c	1b	2a	2C
1A	2b	2c	1a	1B	2a	1c	1b	1C
2A	1a	2b	2c	2B	1b	2a	1c	2C

The Yaraidyana kinship terms are charted on this pattern in Diagram III. There are three lines of male descent and two lines of female descent, the latter being repeated three times. Father and son marry alternately into these two female lines, and women in three consecutive generations take their husbands in regular rotation from the three male lines. The female lines are repeated because each woman must appear in one generation as a daughter, and as wife and mother in another generation level. The three repetitions are necessary in order that the sister and the wife of each man of the three clans may appear on the horizontal line of his own generation.

It will be noted that the kinship terms *upunga*, *ibatha*, and *ilamu* are shared between the A and C lines, and that the terms *ukuta* and *amitha* in the senior generations of the B and C lines appear in the junior generations of the C and B lines, as *ukuka* and *amuka*.

This genealogical pattern expresses marriages by exchange. *Ego* exchanges sister's daughters with *aiyuwin* (f.s.r.s.), or sisters with *mauwara* (f.m.b.s.s. or m.m.b.s.), *apitha* (m.m.f.y.b.), or *apuka* ("o.b.d.d.s."). Miss McConnel, however, records that the Yaraidyana marriages usually follow the junior marriage rule whereby brother and sister marry apart, the brother to a junior and the sister to a senior mate. She also states that observance of the m.b.d.d. taboo debars exchange marriages in successive generations. These conditions indicate that the pattern of Diagram III at least should be doubled.

The genealogical pattern of Diagram III can be reproduced in six lines of male descent and four lines of female descent by exposition of the following marriage diagram (a):

1A1=1c1	1A2=1c2	1B1=2c1	1B2=2c2	1C1=1a1	1C2=1a2
2A1=2b1	2A2=2b2	2B1=2a1	2B2=2a2	2C1=1b1	2C2=1b2

This diagram presents three groups of two pairs with marriage by exchange of sisters between the members of the pairs. The system of marriages can be re-arranged in each of these groups in two ways:

(1) If the marriages be alternated, exchange of sisters will not occur. For example the system

1A1=1c1	1A2=1c2	will become	1A1=1c1	1A2=1c2
1a1=1C1	1a2=1C2		1a1=1C2	1a2=1C1

(2) If the marriages be inverted the above systems will become:

1A1=1c2	1A2=1c1	and	1A1=1c2	1A2=1c1	respectively.
1a1=1C2	1a2=1C1		1a1=1c1	1a2=1C2	

2A1 INATA F.F.F.	1a1 wuraŋa f.f.sr. m.m.m.	2A2	1a2	2B1	2B2 UKUTA M.F.F.	1c1 apitha f.m. m.m.f.sr. w.m.m.m. w.	2C1 AMITHA F.M.F. M.M.F.F.	1c2 "upandi" apitha m.f.sr.d.	2C2 AMITHA M.F.S.R.H.
1A1 WURATHA F.F.	2c1 anitha m.m.	1A2 UPUNGA f.f.f.y.B. M.F.S.R.D.H.	2c2 "inaga" tubu m.f.f.	1B1 ATUTHA M.F.	1B2 ATUTHA M.F.	2a1 inaga f.g.sr. aiyuwihm w.m.m.	1C1 APITHA F.M.B. M.M.F.	2a2 ameri m.b.w.	1C2 "UPUNGA" M.F.S.R.S.
2A1 INATA F.O.B. IBATHA F.	2b2 ukuta m.k.sr. m.g.sr. inyungu m.	2A2	2b1	2B1 ARATHA F.Y.S.R.H. W.M.F.	2B2 UKUTA ARATHA M.O.B. M.Y.B. S.R.D.H.	1b1 aiyuwih f.g.sr.d. w.m.	2C1 AMITHA F.M.B.S. M.M.B. W.F.	1b2 ameri m.b.d.	2C2 "IBATHA" ULBU M.B.D.H.
1A1 UPUNGA ITAMU O.B. EGO Y.B.	1a1 upandi m.sr. y.sr.	1A2 ITAMU Y.B. M.B.D.D.H.	1a2	1B1 AIYUWIN F.Y.S.R.S. W.M.B.	1B2 UWAN AIYUWIN M.O.B.S. M.Y.B.S. S.R.D.H.	1c1 mauwara w.	1C1 MAUWARA W.B. S.R.H.	1c2 "lamu" piugara m.b.d.d.	1C2 "ITAMU" PIUGARA M.B.D.S.
2A1 AMAIKI INIKA O.B.S. Y.B.S. AMAIKI S.	2c1 ukuka o.sr.d. g.sr.d.	2A2	2c2 "upandi" m.b.d.s.	2B1 AMUKA W.M.B.S. D.H.	2B2 AMUKA M.B.S.S. S.W.B.	2a1 amaiki o.b.d. g.b.d. inyika d.	2C1 ULBU UKUKA O.S.R.S. Y.S.R.S. f.D.D.H.	2a2 inagan inuka m.b.s.s.w.	2C2 ULBU M.B.D.S.S.
1A1 WURUKA S.S.	2b2 amuka g.sr.d.f. f.g.B.	1A2	2b1 amuka d.s.d.	1B1 ATUKA D.S.	1B2 ATUKA M.B.S.S.S.	1b1 atuka d.d. aiyuwih	1C1 APUKA D.D.S. S.D.H.	1b2 inagan atuka m.b.s.s.d. ameri	1C2 APUKA
2A1 INUKA S.S.S.	1a1 wuruka s.d.	2A2	1a2	2B1 AMUKA D.S.S.	2B2	1c1 apuka d.d. s.s.w. w.	2C1 UKUKA S.D.S.	1c2 apuka piugara	2C2

DIAGRAM IV.

Varaidyana Kinship Terms charted on the Genealogical Pattern of the Marriage diagram.

1A1 - 1c1 1A2 1c2 1B1 = 2c1 1B2 = 2c1 1C1 = 1a1 1C2 - 1a2
2A1 = 2b2 2A2 = 2b1 2B1 - 2a1 2B2 = 2a2 2C1 = 1b1 2C2 = 1b2

The marriage diagram (b):

1A1-1c1	1A2=1c2	1B1=2c2	1B2=2c1	1C1=1a1	1C2=1a2
2A1=2b2	2A2=2b1	2B1=2a1	2B2=2a2	2C1=1b1	2C2=1b2

expresses alternated marriages in the 1B-2C, and the 2A-2B groups, but retains sister exchange in the 1A-1C group.

The genealogical pattern of this marriage diagram is illustrated in Diagram IV in a partial form, the four lines of female descent being given only once. The pattern shows the three generation cycle of female descent seen in Diagram III. Yaraidyana kinship terms are charted on the pattern in relation to *Ego* 1A1. The plotting of these kinship terms can be followed if a man's sister is located to identify his *mother*, and a man's son's sister located to identify *daughter* and her mother who is his *wife*. Generations become so mixed in this pattern that brother and sister may be separated by one or two generations and merge with kin of analogous status of more remote generations.

The pattern of Diagram IV provides a threefold conformity with kinship requirements in that *wife* may be f.m.b.s.d., m.m.b.d., and f.s.r.d.d. without incurring the tabood kinship of m.b.d.d. This will hold good if *Ego* be 1A1, 1A2, 1C1 or 1C2.

If *Ego* be 1B1, 1B2, 2B1, or 2B2, conformity is only twofold as m.m.b.d. becomes identified with m.b.d.d.

If *Ego* be 2A1, 2A2, 2C1, or 2C2, f.m.b.s.d. and f.s.r.d.d. will be found to be also m.b.d.d., and m.m.b.d. to be the wrong line. Son's wife and daughter's daughter's husband are therefore shown with the prefix $\frac{1}{2}$ in Diagram IV.

A marriage diagram of type (b), but in which the group 2A-2B retains sister exchange, will provide a genealogical pattern which will give threefold conformity if *Ego* be a member of one of the pairs of this group, twofold conformity if *Ego* be of the pairs 1C or 2C, and no conformity if *Ego* be of the pairs 1A or 1B.

An analogous marriage diagram in which the group 1B-2C retains sister exchange will give a pattern with threefold conformity if *Ego* be of this group, twofold if *Ego* be of the pairs 1A or 2A, and no conformity if *Ego* be of the pairs 2B or 1C.

If the marriages of any two of the groups in the above type (b) of marriage diagram be inverted the pattern will be unchanged. If the marriages of one or three of the groups be inverted, a pattern with a six generation cycle of female descent will appear which will not conform to the Yaraidyana terminology.

If the marriages of all three groups of marriage diagram (a) be alternated, the genealogical patterns give a six generation cycle of descent in two of the four female lines. These patterns provide threefold conformity if *Ego* be a member of one of the pairs 1A, 2B, or 2C or alternatively if *Ego* is a member of one of the pairs 2A, 1B, or 1C. A pattern expressing conformity when *Ego* is a member of one of these series of pairs has no conformity when *Ego* is a member of one of the other series. If a marriage diagram for one type of pattern be re-arranged so that the marriages of one or of three of the groups of two pairs be inverted, a pattern will emerge which will be of the alternate type.

Marriage diagrams, in which the marriages of only one group of diagram (a) are alternated, and sister exchange retained by two groups, provide genealogical patterns which do not conform to the Yaraidyana terminology.

Therefore, so far as I can determine, no single genealogical pattern can be found to represent the social organisation of the Yaraidyana.

Miss McConnel (1952) has informed me that clans play no part in marriage arrangements, and that the system is kept "straight" by the use of the terms *ma:em* and *imalgan*, which are applied to sister's husband and brother's wife

2A INATA F.F.F. M.F.SR.H.	1a wuraŋtha f.f.sr. m.m.m.	2b arukan f.f.m.	1c	2B ARUKAN M.F.F. F.M.F.	1b atitha m.f.sr.	2c	2a inata f.f.f.sr.	2C AIYUWIN M.M.F.
1A WURATHA F.F.	1c anitha m.m.	1a wuraŋtha f.f.sr.	2b	1B ATITHA M.F. F.M.B.	2a anyuta f.f.sr. w.m.m.	1b atitha m.f.sr. f.m.	2c	1C AMITHA M.M.B. W.M.F.
2A IBATHA F.	2B adthutha m.	1c	1a	2B UKUTA ARATHA M.B. F.M.B.S. W.F.	2c aiywin f.sr.d. w.m.	2a anyuta f.sr.	1b	2C AIYUWIN M.M.B.S. F.SR.S. W.M.B. SR.H.
1A UPUNGA O.B. EGO	1a upandi o.sr.	2b	1c	1B ATHAKIN M.B.S. W.B. SR.D.H.	1b athakin f.sr.d.d. w.	2c	2a	1C ULBU SR.S. D.H.
2A UMINYU S.	1c ulbu sr.d.	1a	2b amukan s.d.	2B AMUKAN W.B.S. SR.D.S. D.D.H.	2a uminyu d.	1b	2c	2C ATUKAN D.S. S.D.H.
1A WURUKAN S.S.	2b amukan sr.d.d. s.d.	1c	1a wurukan s.d.	1B ATHAKIN D.D.S.	2c atukan d.d.	2a	1b	1C UKUKA S.D.S.

DIAGRAM V.

Nggamiti Kinship Terms. Marriage Diagram.

2A = 2b 2B = 2c 2C = 1a
1A = 1b 1B = 1c 1C = 2a

when these are "outside" persons. The above discussion indicates that much compromise and readjustment must be necessary to make the system workable.

The Nggamiti system is not described in detail by Miss McConnel. Diagram V shows that the kinship terms will conform to a genealogical pattern based on the marriage diagram:

$$\begin{array}{lll} 1A=1b & 1B=1c & 1C=2a \\ 2A=2b & 2B=2c & 2C=1a \end{array}$$

or, in the form representing marriages of brothers and sisters,

$$\begin{array}{ll} & 1B=1c \\ 1A=1b & 1C=2a \\ 1a=2C & 2b=2A \\ & 2c=2B \end{array}$$

The pattern of Diagram V represents exchange marriages in which *Ego* gives his sister to *aiyuwin* (f.s.r.s. or m.m.b.s.) in return for the latter's sister's daughter, or gives his sister's daughter to *athakin* (m.b.s.) in return for the latter's sister. The terms *ukuta*, *atitha* and *amitha* in the Nggamiti system appear in the alternate lines in junior generations as *ukuka*, *atukan* and *amukan*.

The description of the Yaraidyana and Nggamiti systems is a tribute to Miss McConnel's patient research, and has set a problem for those who are interested in kinships. These systems appear to be quite anomalous, and without significance in regard to the development of the dominant type of aboriginal marriage and kinship.

The Wikmunkan (a) and the Kandyu systems have been seen to approximate to the dominant type, but it would seem to be more probable that this approximation is due to a compromise between the existing Wikmunkan (b) system and the dominant type rather than representing a stage in the evolution of the latter.

The following conclusions are therefore presented.

There is one dominant type of aboriginal marriage and kinship in Australia. Typically, marriages are arranged by an exchange of second cousins. The consequent kinship pattern has a patrilineal and a matrilineal form.

A simpler kinship terminology is common in borderland regions where members of patrilineal and matrilineal societies intermarry. Detribalisation has a similar result. These simpler kinship terminologies have suggested that a custom of bilateral first-cousin marriages was prevalent in such regions.

This led to the hypothesis that descriptions of existing systems of aboriginal kinship terminology and class (section) nomenclature are evidence of an evolution of marriage custom from that of first-cousins to that of second-cousins. This hypothesis is discredited.

The systems of unilateral first-cousin marriages of junior type in Northern Australia are fundamentally different from the dominant system, and the complex social organizations of the former are not prototypes of those of the latter.

The complexity of these junior-marriage systems is realised when diagrammatic presentation is attempted. Diagrams of the marriages of brother and sister occupy two dimensions. Successive generations represent a third dimension. Representation of senior and junior status requires yet another dimension. Therefore, attempts to create a picture of the social organization of one of these tribes have to contend with a four-dimensional problem.

Finally, it is of interest to note that these aboriginals of Australia in dealing with the practical issues of their social organization had to cope with genealogical problems in which the mathematical abstractions of relativity and four dimensions were concealed.

APPENDIX

The simplest genealogical pattern to express marriage with the father's sister's daughter's daughter in a matrilineal society is one based on Diagram II with a reversal of sex symbols.

If generation lines be numbered consecutively the following pattern will develop:

1A1	1a1	1B1	1b1	1A2	1a2	1B2	1b2
2B1	2a1	2A2	2b1	2B2	2a2	2A1	2b2
	3a1		3b1		3a2		3b2
4A1	4a1	4B1	4b1	4A2	4a2	4B2	4b2
5B1	5a1	5A2	5b1	5B2	5a2	5A1	5b2
	6a1		6b1		6a2		6b2
7A1	7a1	7B1	7b1	7A2	7a2	7B2	7b2

Men of generations numbered 4 and 7 are sons of men of generations numbered 2 and 5, and of women of generations 3 and 6 whose brothers can find no representation in the pattern.

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**THE MOLLUSCAN FAUNA OF THE PLIOCENE STRATA
UNDERLYING THE ADELAIDE PLAINS
PART IV-GASTROPODA (TURRITELLIDAE TO STRUTHIOLARIIDAE)**

BY N. H. LUDBROOK

Summary

Part IV of the study of the mollusca from borings into the Dry Creek Sands consists of a revision of the gastropod superfamilies Cerithiacea, Scalacea, Pyramidellacea, Hipponicacea, Calyptraeacea. The nomenclature of 48 species has been revised, 1 new genus, 2 new subgenera and 16 new species have been described.

The occurrence of a very thin remnant of the Dry Creek Sands outcropping in the River Light is placed on record as the most northerly exposure of the Pliocene in the Adelaide Basin.

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[Read 12 April, 1956]

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The nomenclature of 48 species has been revised, 1 new genus, 2 new subgenera and 16 new species have been described.

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INTRODUCTION

Late in 1955, a very thin remnant of Pliocene calcareous sandstone overlying Oligo-Miocene yellow fossiliferous limestone was observed in an outlier at Redbands, on the River Light, $3\frac{1}{2}$ miles east-south-east of Mallala, Section 5, Hundred of Grace. Although the total rock exposure is very small, an assemblage characteristic of the Dry Creek Sands has been identified from moulds, casts and chalky shell remains. Species include *Glycymeris convexa* (Tate), *Chlamys antiaustralis* (Tate), *Miltha hora* (Cotton), *Dentalium latesulcatum* Tate, *Turritella acricula adelaidensis* Cotton & Woods, *Diastoma provisi* Tate, *Theridium torri* (Tate), *Polinices substolida* (Tate), *Conus* (*Floraconus*) sp. nov.

Opportunity is taken of placing this occurrence on record as relevant to the present study. It extends considerably to the north the occurrence of the Pliocene Dry Creek Sands in the Basin.

The methods employed in describing the fauna have been outlined in Parts I (this Journal, vol. 77), II (vol. 78), and III (vol. 79). Part IV includes the Pyramidellacea, the systematic position of which is not yet firmly established.

Modern zoologists tend to place them with the Opisthobranchia.

Superfamily CERITHIACEA

Family TURRITELLIDAE

Genus TURRITELLA Lamarck, 1799

Turritella Lamarck, 1799, Mem. Soc. Hist. Nat. Paris, p. 74.

Type species (o.d.) *Turbo terebra* Linné

Subgenus GAZAMEDA Iredale, 1924

Gazameda Iredale, 1924, Proc. Linn. Soc. N.S.W., 49 (3), 197, p. 247.

Type species (monotypy) *Turritella gunnii* Reeve

Turritella (*Gazameda*) *acricula adelaidensis* Cotton & Woods

Turritella (*Gazameda*) *acricula adelaidensis* Cotton & Woods, 1935, Rec. S. Aust. Mus., 3 (3), p. 376, text fig. 2.

Gazameda adelaidensis Cotton & Woods, Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Turritella (*Haustator*) *acricula adelaidensis* Cotton & Woods, Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Acutely lanceolate, with turreted apex of 2 narrow convex turns, ephebie whorls smooth and sharply carinated at the middle. Adult whorls tending to uncoil with resultant deep excavation at the anterior suture. Sculpture very variable, rough, generally of about 12 subequal spiral threads, of which the medial 2 to 4 are the stronger and more widely spaced, and secondary interstitial spiral threads all crossed by medially arched growth axials of almost equal strength to the spirals, producing rhombic cancellation or punctation.

Dimensions—Height 37, diameter 7 mm.

Type Locality—Abattoirs Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1681.

Observations—The species *acricula* (*sensu lato*) is very variable and it is difficult to decide whether *adelaiddensis* should be separated from it specifically or subspecifically. *Adelaiddensis* is generally more coarsely sculptured than *acricula* s. str., particularly in the strength of the axials and resultant cancellation. The early whorls are identical with those of *acricula*, and many specimens are inseparable from the typical species.

In the opinion of Dr. J. Marwick (personal communication) *Gazameda* should be separated from *Haustator* under which the writer listed the species (1954, p. 59).

Material—Numerous specimens Hindmarsh Bore, 28 specimens Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

***Turritella* (*Gazameda*) *subacricula* Cotton & Woods**

Turritella (*Gazameda*) *subacricula* Cotton & Woods, 1935, Rec. S. Aust. Mus., 5 (3), p. 376, text fig. 2.

Gazameda subacricula Cotton & Woods, Cotton, 1952, Geol. Surv. S. Aust. Bull., 27, appendix 4, p. 245.

Turritella (*Haustator*) *subacricula* Cotton & Woods, Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Sharply turreted, whorls markedly convex, sculpture of 4 major spiral ribs and indistinct secondary ribs crossed by marked axial growth striae.

Dimensions—Height 40.5, diameter 7.8 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1686.

Material—4 incomplete specimens, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Hindmarsh Bores, Adelaide.

Subgenus *Ctenocolpus* Iredale, 1925

Ctenocolpus Iredale, 1925, Rec. Aust. Mus., 14, pp. 249, 266.

Type species (monotypy) *Turritella australis* Lamarck

***Turritella* (*Ctenocolpus*) *trilix* Cotton & Woods**

Turritella (*Ctenocolpus*) *trilix* Cotton & Woods, 1935, Rec. S. Aust. Mus., 5 (3), p. 377, text fig. 4; Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Ctenocolpus trilix Cotton & Woods, Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—Small, whorls flattened, protoconch oblique. Sculpture of 3 distinct major spiral ribs with wide, smooth interspaces. One secondary sub-sutural spiral.

Dimensions—Height 6.5, diameter 2.5 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1675.

Material—3 specimens, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide.

Subgenus COLPOSPIRA Donald, 1900

Colpospira Donald, 1900, Proc. Mal. Soc., 4 (2), p. 51.

Type species (n.d.) *Turritella runcinata* Watson.

Turritella (*Colpospira*) *platyspiroides* sp. nov.

pl. 2, figs. 1, 2.

Turritella sp. aff. *platyspira* T. Woods, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A rather small *Colpospira* with protoconch of one-and-a-half smooth globose turns. Adult whorls smooth, shining, flattish, rather constricted posteriorly, and in the earlier whorls slightly carinate in the anterior quarter. Later adult whorls with a second carina developed at the posterior one-quarter with a flat, smooth area between them. Periphery sharply angulate, base flattish.

Description of Holotype—Spire broken, adult whorls smooth, shining, nearly flat, at first carinate in the anterior and posterior one-quarter, with a flattened medial area between them. Periphery sharply angulate. Surface smooth except for fine axial growth lines revealing a deep, broad median apertural sinus and occasional spiral threads. There is a small cord on each carina and on the periphery. Base flattish, with 6 fine spiral lirae. Aperture subquadrate, outer lip with a broad median sinus.

Description of Paratype—Immature shell, showing the early whorls. Protoconch of one-and-a-half smooth globose turns, adult whorls at first flat with an anterior carina developing at the fourth adult whorl. Whorls gradually increasing, spire sharply tapering.

Dimensions—Total estimated height 18.5, diameter 5 mm.

Type Locality—Abattoirs Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15156.

Observations—The four examples of this species were previously referred to *platyspira* Tenison-Woods, from which the species differs in being larger and thicker, with a wider spire more gradually tapering than that of *platyspira*. The sculpture also differs.

Material—Holotype and 3 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Subgenus MAORICOLPUS Finlay, 1927

Maoricolpus Finlay, 1927, Trans. N.Z. Inst., 57, p. 389.

Type species (n.d.) *Turritella rosea* Quoy & Gaimard.

Turritella (*Maoricolpus*) *murrayana subrudis* Cotton & Woods

Turritella (*Maoricolpus*) *murrayana subrudis* Cotton & Woods, 1935, Rec. S. Aust. Mus., 5 (3), p. 371.

Maoricolpus subrudis Cotton & Woods, Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Turritella (*Pegrella*) *murrayana subrudis* Cotton & Woods, Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Fairly large, whorls 12 to 14, flat and medially depressed. Apical angle 15 deg. Anterior suture slightly carinate. Early spire whorls only slightly inflated and carinate at the anterior one-third. Sculpture strong and coarse, of about 12 primary spiral lirae with fine secondary lirae between; lirae stronger in the median depressed portion of the whorl.

Dimensions—Height 49, diameter 12 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1688.

Observations—Like *T. (Gazameda) acricula adelaidensis*, the present subspecies is a coarsely sculptured form of the typical species. In view of the range of variation in the sculpture of *murrayana*, one hesitates to separate the Dry

Creek Sands variant specifically, particularly as strengthening of the sculpture seems to be common to several species of this formation. The species *murrayana* may be long-ranging and widespread, but the amount of material available for comparison is small.

Material—Holotype and 19 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Family MATHILDIDAE.

Genus VALSANTIA gen. nov.

Generic Characters—Shell very small, imperforate, solid. Protoconch small, paucigyrate, slightly inclined, immersed at the origin and smooth for one whorl followed by a brephic whorl with sharp, narrow axials. Adult whorls strongly and conspicuously cancellate. Aperture with outer lip expanded, channelled within corresponding to external spiral ribs, and conspicuously denticulate. Columella straight, with two median plaits. Inner lip slightly effuse at base.

Type species *Valsantia spectabilis* sp. nov.

Valsantia spectabilis sp. nov.

pl. 2, fig. 3.

Diagnosis—Protoconch small, smooth and immersed at tip, followed by one post-nuclear whorl with 10 sharp, narrow axials. Adult whorls four in a height of 4 mm. Sculpture of 3 strong spiral ribs, the median of which is on a carina, and one weaker subsutural rib, all crossed by axial costae narrower than the spirals but strong, elevated and laterally compressed. Interspaces deep, rhombic, intersections tuberculate. Base with 2 tuberculate spiral ribs. Columella with two median plaits.

Description of Holotype—Shell very small, solid, turreted, spire fairly low for the family, whorls relatively few. Apex small, paucigyrate, immersed at tip, slightly inclined, first whorl smooth, first post-nuclear whorl with 10 brephic axials. Adult whorls four, sculptured with 3 strong spiral ribs, the median of which is stronger and supported by a keel and one weaker subsutural rib all crossed obliquely and tuberculated by axial costae narrower than the spirals but elevated and compressed laterally. Interspaces deep and rhombic. Suture deep, canaliculate. Body whorl a little less than half the height of the shell, aperture about half height of the body whorl. Base convexly oblique with 2 spiral tuberculate ribs and a third inconspicuous tuberculate rib bordering the columella. Aperture sub-elliptical with outer lip well-rounded and expanded, canaliculate within corresponding to the external ribs which are produced externally beyond the axial margin, and inconspicuously denticulate with long, flat denticles. Columella straight, oblique, with two plaits well-spaced medially. Inner lip reflected over columella and slightly effuse anteriorly.

Dimensions—Height 4, diameter 2, height of body whorl 2.5 mm.

Type Locality—Hindmarsh Bore, 450-487 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15157.

Observations—This is a very elegant and interesting shell. Without the protoconch and columella features, it is reminiscent of *Mathilda* (*Optimilda*) *decorata* Hedley. However, the plaits on the columella are distinctive, and are possessed by no other genus, so far as can be determined, in the family. In apical characters, the genus comes closest to *Gegania* Jeffreys; the heterostrophic strongly tilted apex of *Mathilda* is not present, the apex being only slightly tilted and immersed at the origin. The apical characters and the sculpture suggest the subgenus *Tubena* Marwick created for *Gegania* (*Tubena*) *viola* Marwick from the New Zealand Awamoan. Both *Gegania* s. str. and *G.* (*Tubena*) are thin shells; *Valsantia* is solid for its size.

The species was inadvertently listed (Ludbrook, 1954, p. 59) as *Glyptozaria spectabilis* sp. nov.

Material—Holotype, Hindmarsh Bore; 3 paratypes, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Weymouth's Bores, Adelaide.

Family ARCHITECTONIDAE.

Genus ARCHITECTONICA Röding, 1798.

Architectonica Röding ex Bolten, 1798, Mus. Bolt., 2, p. 78.

(*Solarium* Lamarek, 1799, Mem. Soc. Hist. nat. Paris, 1, p. 71.)

Type species (s.d. Gray, 1847) *Trochus perspectiva* Linné.

Subgenus DISCOTECTONICA Marwick, 1931.

Discotectonica Marwick, 1931, N.Z. Geol. Surv. Pal. Bull., 13, p. 101.

Type species (n.d.) *Architectonica balcombensis* Finlay.

Architectonica (*Discotectonica*) *wannonensis* (Tenison Woods)

pl. 2, figs. 4, 5.

Solarium wannonensis Tenison-Woods, 1879, Proc. Linn. Soc. N.S.W., 3 (3), p. 237, pl. 21, fig. 10.

Helicostoma wannonensis Tenison-Woods sp. Harris, 1897, Cat. Tert. Moll. Brit. Mus., 1, p. 245; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 112; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Architectonica wannonensis, T. Woods, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Architectonica (*Discotectonica*) *wannonensis* (Tenison-Woods), Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—A *Discotectonica* which is flatly convex above and convex below; whorls sculptured with granular spiral cords, increasing in number from 3 on the first adult whorl to 5 on the penultimate whorl, of which the infrasutural is stronger with fewer and larger granules, followed by three cords with smaller and more numerous granules equal in number to those of the previous three cords. An additional small cord shows at the suture, representing the incomplete embracing of the peripheral cord by the aperture. Peripheral cord strong and ovately-granular. Base convex with 6 cords with small granules followed by 3 cords of large and less numerous granules bordering the umbilicus. Aperture round within; inner lip angularly expanded at the junction with the peripheral cord and similarly expanded below at the position of the umbilical cord.

Dimensions of Hypotype—Height 2, diameter 6 mm.

Type Locality—Muddy Creek, Victoria.

Location of Holotype—Australian Museum, Sydney, F 1818.

Location of Hypotype—Tate Mus. Coll., F 15158.

Observations—The hypotype is twice the size of the holotype, and has been compared with authentic topotypes.

Material—Hypotype, Weymouth's Bore, 310-330 feet, 2 topotypes, Muddy Creek, Victoria (B.M. Coll.).

Stratigraphical Range—?Balcombian; Dry Creek Sands.

Geographical Distribution—Port Phillip Bay, Victoria, to Adelaide, South Australia.

Family VERMETIDAE.

Genus TENAGODUS Guettard, 1770.

Tenagodus Guettard, 1770, Mem. diff. Sci., 3, p. 128.

(*Siliquaria* Bruguière, 1799, Ency. Meth. (Vers.), 1, p. 15.)

(*Tenagodes* P. Fischer, 1885, Man. de Conch., p. 692.)

Type species (monotypy) *Serpula anguinus* Linné

Subgenus TENAGODUS s. str.

(*Montfortia* Della Campana, 1890, Atti Soc. Ligust., 1, p. 139, non Recluz, 1843.)

(*Hemitenagodes* Rovereto, 1899, id., 10, p. 108, nom. nov. for *Montfortia*.)

Tenagodus australis (Quoy & Gaimard)

Siliquaria australis Quoy & Gaimard, 1834, in d'Urville, Voy. "Astrolabe" Zool., 3, p. 302; Cotton & Godfrey, 1931, S. Aust. Nat., 12 (4), p. 63, pl. 2, fig. 13; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Tenagodes australis Q. & G., Tate, 1890, Trans. Roy. Soc. S. Aust., 13 (2), p. 177; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 144.

Tenagodus australis (Q. & G.), Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Fairly large, ventrifiform, whorls about 5 at first spiral then irregularly coiled, angulated behind. Growth lines prominent, slit at first closed, followed by open, round holes, then a conspicuous, open and denticulated slit.

Dimensions—Length 105, greatest diameter of the tube at the base, 17 mm.

Type Locality—Westernport, Victoria; Recent.

Location of Holotype—Mus. d'Hist. nat. Paris.

Material—Portions of tubes, Hindmarsh, Weymouth's and Kooyonga Bores; numerous specimens, Abattoirs Bore.

Stratigraphical Range—Pliocene to Recent.

Geographical Distribution—Victoria, Tasmania and South Australia.

Family DIASTOMIDAE.

Genus DIASTOMA Deshayes, 1850,

Diastoma Deshayes, 1850, Traité elem. Conch. Atlas, p. 46.

Type species (monotypy) *Diastoma costellata* Deshayes = *Melania costellata* Lamarck.

Diastoma provisi Tate

pl. 1, fig. 4.

Diastoma provisi Tate, 1894, Journ. Roy. Soc. N.S.W. for 1893, 27, p. 177, pl. 10, fig. 6; Harris, 1897, Cat. Tert. Moll. Brit. Mus., 1, p. 232; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 138, 144; Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Neodiastoma provisi Tate, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—Adult whorls about 10, sculptured with about 18 axial costae per whorl, both costae and interspaces bearing fine axial growth striae, crossed by fine, frequent spiral threads, generally alternating in strength. The axial costae are interrupted at the posterior four-fifths of each whorl by a narrow impressed channel. Suture impressed, whorls overlapping. Whorls more or less varicate. Aperture loop-shaped, columella with a single plication; callosity reflected behind columella ridge.

Dimensions—Height 46, diameter 14, length of aperture 15, width of aperture 7 mm.

Type Locality—Dry Creek Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1541.

Observations—*Diastoma provisi* is a restricted and typical fossil of the Dry Creek Sands and their equivalents. In the opinion of M. Chavan (personal communication) it is a true *Diastoma* and not related to *Neodiastoma*, type species *Mesalia melanoloides* Reeve.

Material—Holotype and paratypes, Dry Creek Bore; numerous specimens Abattoirs Bore; 10 specimens Kooyonga Bore; 6 specimens Hindmarsh Bore; 3 specimens and fragments, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District, Hallett Cove, Eyre Peninsula.

Genus ORTORTIO Hedley, 1899.

Ortortio Hedley, 1899, Mem. Aust. Mus., 3 (3), p. 412.

Type species (monotypy) *Rissoa pyrrhacme* Melvill & Standen.

Obtortio liratus Ludbrook

Obtortio liratus Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 90, pl. 4, fig. 24; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245; Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Small, 7 adult whorls in a height of 5.2 mm., angulate at posterior one-third. Sculpture of 14 curved axial costae per whorl, crossed by prominent spiral lirae, absent or obsolete posterior to the angle. Base spirally lirate, aperture subovate with a short anterior canal.

Dimensions—Height 5.2, diameter 1.7 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1656.

Observations—*Obtortio* is an Indo-Pacific genus, here represented by the one species, occurring in small numbers in Abattoirs and Weymouth's Bores.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide.

Family POTAMIDIDAE.

Subfamily BATILLARIINAE.

Genus BATILLARIA Benson, 1842.

Batillaria Benson, 1842, Ann. Mag. Nat. Hist., 9, p. 488.

(*Lampania* Gray, 1847, Proc. Zool. Soc., 15, p. 153.)

Type species (monotypy) *Batillaria zonalis* = *Cerithium zonalis* Bruguière.

Subgenus ZEACUMANTUS Finlay, 1927.

Zeacumantus Finlay, 1927, Trans. N.Z. Inst., 57, p. 380.

Type species (o.d.) *Cerithium subcarinatum* Sowerby.

Batillaria (Zeacumantus) diemenensis (Quoy & Gaimard)

Cerithium diemenensis Quoy & Gaimard, 1834, Voy. Astrolabe, Zool., 3, p. 128, pl. 55, figs. 11-13.

Zeacumantus diemenensis Q. & G., Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Batillaria (Zeacumantus) diemenensis (Q. & G.), Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Total of 9 whorls in a height of 18 mm., axially plicate, with about 10 plications on the penultimate whorl and four spiral striae on each whorl. Aperture subovate, oblique, with a short recurved anterior canal.

Dimensions—Height 18 mm.

Type Locality—Tasmania, Recent.

Location of Holotype—Mus. d'Hist. nat. Paris.

Material—One worn specimen, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands, and Recent.

Geographical Distribution—Southern Australia.

Batillaria (Zeacumantus) bivaricata (Ludbrook)

Clypeomorus bivaricatus Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 89; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Batillaria (Zeacumantus) bivaricata Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Protoconch of one-and-a-half whorls and nine adult whorls in a height of 11 mm. Whorls angulate at the posterior third, almost vertical in anterior two-thirds. Angulation more pronounced in early whorls, body whorl convex. Sculpture of curved axial costae, about 15 on the penultimate whorl, tuberculate at the angle, crossed by about six strong spiral lirae in the anterior two-thirds and four much weaker, more closely set lirae above the shoulder; the number of lirae increases by intercalation from two on the earliest whorls. Six fine spiral lirae on the base. Two varices on each whorl.

Dimensions—Height 11, diameter 3.1 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T1629.

Observations—This species does not belong to *Clypeomorus* where it was originally described. Although its aperture has some features in common with that genus, the shape, texture and sculpture are very distinct. It is difficult to obtain a specimen with a mature or complete aperture; two, including the holotype, among the numerous specimens from Abattoirs Bore, have complete apertures. The affinities are with *B. (Z.) subcarinatum* Sowerby. Immature shells show similar features in both species.

Material—Numerous paratypes. Abattoirs Bore; 30 specimens Weymouth's Bore; 8 specimens Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Batillaria (Zeacumantus) multilirata (Ludbrook)

Clypeomorus multiliratus Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 89, pl. 1, fig. 22; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Batillaria (Zeacumantus) multilirata Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Protoconch of three relatively large, convex whorls. Adult whorls sculptured with curved axial costae increasing from seven in the first whorl to eleven in the body whorl, crossed by numerous fine lirae, wider than interspaces, about fifteen in number on the penultimate whorl. Three varices per whorl.

Dimensions—Height 9.7, diameter 3.6 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T1633.

Observations—Like the preceding species, *multilirata* should not have been placed in *Clypeomorus*. It is readily distinguishable from *bivariata* by the absence of angulation in the early whorls and the 3 varices on each whorl. No complete specimens have as yet been found, and apertural features are still indeterminable.

Material—13 paratypes, Abattoirs Bore; 28 specimens. Hindmarsh Bore; 9 specimens, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Subgenus *BATILLARIELLA* Thiele, 1929.

Batillariella Thiele, 1929, Handb. Syst. Weicht., 1, p. 208.

Type species (monotypy) *Billium estuarinum* Tate

Batillaria (Batillariella) estuarina (Tate)

Billium estuarinum Tate, 1893, Trans. Roy. Soc. S. Aust., 17 (1), p. 190, pl. 5, fig. 12.

Batillaria (Batillariella) estuarina (Tate), Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Twelve whorls in a height of 22 mm., early spire whorls medially angulate; sculpture of slightly arched axial plicae, about 12 on the penultimate whorl, and about six primary spiral lirae on the penultimate whorl, and five secondary lirae rising between them. Interspaces and plicae fine, axially striate with crowded lines of growth. Aperture subcircular, somewhat effuse at the base and obliquely angulated.

Dimensions—Height 22, diameter 5 mm.

Type Locality—Port Adelaide Creek, between tidemarks; Recent.

Location of Holotype—S. Aust. Mus.

Observations—The only fossil example of *estuarina* is small and possibly juvenile. It is doubtfully conspecific with living topotypes from Port River, but is comparable with specimens from Western Australia which are smaller and more strongly sculptured.

Material—One specimen, Abattoirs Bore; 12 specimens, Western Australia; 15 specimens, Port River, Adelaide (B.M. Coll.).

Stratigraphical Range—Dry Creek Sands and Recent.

Geographical Distribution—South Australia to Western Australia, estuarine, between tidemarks.

Genus *MANULONA* Ludbrook, 1941.

Manulona Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 91.

Type species (o.d.) *Manulona arrugosa* Ludbrook.

Manulona arrugosa Ludbrook

Manulona arrugosa Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 91, pl. 4, fig. 26; Ludbrook, 1951, *id.*, 77, p. 59.

Diagnosis—Adult whorls 10 in a height of 8.7 mm.; conspicuously sculptured with a supra-sutural thread above which is a prominent band with about 12 elevated tubercles; above the band three flattened beaded lirae, the beads being about twice as numerous and very much smaller than the tubercles. Suture linear, irregular, anterior canal short and slightly reflexed.

Dimensions—Height 8.7, diameter 2.2 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1635.

Material—9 paratypes, Abattoirs Bore; 4 specimens, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide.

Manulona lirasuturalis Ludbrook

Manulona lirasuturalis Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 91, pl. 4, fig. 27; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 246; Ludbrook, 1951, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—Adult whorls 11 in a height of 9.1 mm. Whorls more or less smooth, faintly axially and spirally striate, with a row of about 9 tubercles above the suture giving a carinate appearance to the whorl anteriorly immediately above the suture; below the suture an inconspicuous row of fine, numerous beads. Suture slightly undulating with a single fine lira imbricating above.

Dimensions—Height 9.1, diameter 2.2 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1643.

Material—Seven paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Subfamily ATAXOCERITHIINAE.

Genus ATAXOCERITHIUM Tate, 1894.

Ataxocerithium Tate, 1894, Journ. Roy. Soc. N.S.W., 27, p. 179.

Type species (o.d.) *Cerithium scrothinum* A. Adams.

Ataxocerithium bidenticulatum sp. nov.

pl. 2, figs. 6, 7

cf. *Ataxocerithium* sp. Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—An *Ataxocerithium* with about 26 axial costae on the penultimate whorl crossed by strong spiral cords increasing from three on the first adult whorl to from five to eight on the body whorl. Five on the penultimate whorl. Inner lip with 2 denticles on the columella and one posterior denticle continuing within the aperture as a fairly thick rib bordering a slight posterior canal.

Description of Holotype—Shell of moderate size, apex broken, seven adult whorls remaining; whorls slightly convex, suture deep, canaliculate. Whorls sculptured with narrow axial costae, about 26 on the penultimate whorl, which are crossed and slightly tuberculated by strong spiral cords with straight sides. The cords are not regularly spaced, and on the penultimate whorl the two posterior cords are equal, with interspaces of equivalent width, while the next

two cords are nearly contiguous; the anterior cord is spaced as the two posterior cords. The interspaces are subrectangular and not very deep or sharply outlined. Base convexly oblique with five spiral cords, the lowest of which only partly embraces the anterior canal; there are in addition faint axial growth striae. Aperture quadrately ovate, outer lip broken in the holotype, inner lip thin and recurved over columella with two small denticles on the anterior half and one denticle at the posterior, which continues within the aperture as a fairly thick rib bordering a canal, visible within but not cutting through the outer lip. Anterior canal of moderate length, tubular.

Dimensions—Height 11, diameter 4 mm.

Paratype a—Specimen consisting of last two whorls with aperture complete.

Paratype b—Juvenile with protoconch undamaged. Protoconch sharp and prominent, of one-and-a-half smooth, high convex turns followed by a half turn with brephic axials.

Type Locality—Weymouth's Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15159.

Observations—Finlay (1927, p. 383) has noted that both Australian and New Zealand examples of *Ataxocerithium* occasionally possess a rudimentary plait. The slight denticles which are a distinguishing feature of this species would appear to be a specific character.

Material—Holotype and paratype a, Weymouth's Bore; paratype b and 24 incomplete paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Abattoirs Bores.

Ataxocerithium sp.

Ataxocerithium concatenatum Tate, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Observations—One incomplete specimen from Abattoirs Bore is distinct from *bidenticulatum*. Sculptured with about 30 axial costae per whorl crossed and tuberculated by regular spiral cords of which there are 7 on the penultimate and 9 on the body whorl. The sculpture is finer and more even than in *bidenticulatum* and differs from *concatenatum* with which the shell was previously identified in that the spiral and not the axial sculpture is dominant. Shape of the shell is also distinctive. Whorls are convex and the suture is impressed but not canalliculate as in *bidenticulatum*.

Genus *Adelacerithium* Ludbrook, 1941.

Adelacerithium Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 90.

Type species (monotypy) *Adelacerithium merulum* Ludbrook.

Adelacerithium merulum Ludbrook

Adelacerithium merulum Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 90, pl. 4, fig. 23; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245; Ludbrook, 1954, Trans. Roy. Soc. S. Aust., 77, p. 59.

Diagnosis—14 adult whorls in a height of 9.5 mm. Whorls flattened, sculptured with fine, prominent curved axial costae, 24 on the penultimate whorl, crossed by approximately equidistant spiral lirae, 5 on the penultimate whorl; intersections slightly granulose. Number of costae per whorl rapidly increasing at about the seventh whorl and decreasing in strength towards the aperture. Spiral sculpture variable in later whorls.

Dimensions—Height 9.5, diameter 2.2 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1630.

Observations—The genus *Adelacerithium* is closely related to *Taxonina* Finlay which is restricted to the Nukumaruan in New Zealand. The sculpture in

Adelacerithium is finer, there being 4 to 5 spirals instead of typically three in *Taxonla*. The base of *Taxonla* appears to be less convex than that of *Adelacerithium*, so far as one can tell in the absence of the type species of *Taxonla*.

Material—Holotype and 14 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Family CERITHIIDAE.

Subfamily LITOPINAE.

Genus *DIALA* A. Adams, 1861.

Diala A. Adams, 1861, Ann. Mag. Nat. Hist., ser. 3, 8, p. 242.

Type species (s.d. Fischer, 1885) *Diala varia* A. Adams.

Subgenus *MERELDIA* Ludbrook, 1941.

Mereldia Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 92.

Type species (monotypy) *Mereldia incommoda* Ludbrook.

Diala (*Mereldia*) *incommoda* (Ludbrook)

Mereldia incommoda Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 92.

Diagnosis—A *Mereldia* differing from *Diala* in having a dome-shaped protoconch and persistently striated whorls. Protoconch of two flattened whorls and nine adult whorls in a height of 10 mm. Whorls sculptured with about 16 fine spiral striae per whorl, unequally spaced.

Dimensions—Height 10, diameter 3.6 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1638.

Observations—Introduced with full generic rank, *Mereldia* now appears on examination of a wide range of *Diala* to warrant no more than subgeneric distinction from *Diala* s. str. The shell is a good deal larger than typical *Diala*, and the striations are persistent over the whole shell.

Material—Holotype and 4 paratypes, Abattoirs Bore; 1 specimen, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Hindmarsh Bores.

Subfamily CERITHIINAE.

Genus *BITTIUM* Leach, 1847.

Bittium Leach in Gray, 1847, Ann. Mag. Nat. Hist., 20, p. 270.

(*Cerithium* Tiberi, 1869, Bull. Malac. Ital., 2, p. 263.)

Type species (s.d. Gray, 1847) *Murex reticulatum* Montfort=

Strombiformis reticulatus Da Costa.

Subgenus *SEMIBITTIUM* Cossmann, 1896.

Semibittium Cossmann, 1896, Ann. Soc. Malac. Belg., 31, Mem., p. 29.

(*Cucuzelia* Iredale, 1924, Proc. Linn. Soc. N.S.W., 49, pp. 183, 246, non Grote, 1878.)

(*Cucuzeliana* Strand, 1928, Arch. Naturgesch., 92, A.8, p. 66.)

Type species (s.d. Cossmann, 1906) *Cerithium cancellatum* Lamarck.

Bittium (*Semibittium*) *subgranarium* sp. nov.

pl. 2, fig. 8.

Cucuzeliana cf. *granaria* Kiener, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Cucuzeliana granaria Kiener, Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—Protoconch of three narrowly convex, smooth turns and 8 adult whorls in a height of 4 mm. Diameter one-quarter height. Whorls decreasing in convexity anteriorly. Sculpture on the whorls of five flat spiral cords separated by narrow linear interspaces and about 14 narrow axial costae per whorl. Axial costae cross and tuberculate the posterior three of the spiral cords and fade out on the anterior portion of each whorl so that the anterior two cords are not tuberculate. Four plain spiral cords on the base.

Description of Holotype.—Shell very small, acutely conical. Protoconch somewhat damaged in the holotype, of three narrowly convex turns. Adult whorls 8, feebly convex and decreasing in convexity anteriorly from the early spire whorls to the body whorl. Suture deep. Body whorl about one-third height of shell, subangular at the periphery. Aperture obliquely and narrowly ovate with a short anterior canal, slightly curved to the left. Posterior canal absent. Outer lip somewhat concavely curved, not varicose, but there is a varix behind the lip, about one-quarter way round the body whorl. Ornament on the whorls of five flat spiral cords separated by narrow linear interspaces, and about 14 narrow axial costae per whorl. The axial costae cross and tuberculate the posterior three of the spiral cords and fade out on the anterior portion of each whorl so that the anterior two cords are not tuberculate. Base oblique and slightly convex, with four plain spiral cords.

Dimensions.—Height 4, diameter 1, height of body whorl 1.3 mm.

Type Locality.—Hindmarsh Bore, 450-487 feet.

Location of Holotype.—Tate Mus. Coll., Univ. of Adelaide, F 15180.

Observations.—This species is closely related to the Recent *B. (S.) granarium* Kiener, with which it has previously been compared. It is much smaller than *granarium* which has all the spiral cords on the whorls tuberculate; in *subgranarium* the axial ribs fade out on the anterior portion of the shell where the cords are simple. The posterior three cords only are tuberculated by the axials.

Material.—Holotype and three paratypes, Hindmarsh Bore.

Stratigraphical Range.—Dry Creek Sands.

Geographical Distribution.—Abattoirs and Hindmarsh Bores.

Genus *THERICIUM* Monterosato, 1890.

Theridium Monterosato, 1890, Nat. Sicil., 9, p. 163.

(*Vulgocerithium* Cossmann, 1895, in Sacco, Moll. Terr. terz., 17, p. 7.)

(*Pithocerithium* Sacco, 1895, *ibid.*, p. 28.)

(*Pliocerithium* Monterosato, 1911, Giorn. Sci. Nat. Econ. Palermo, 28, p. 67.)

(*Gladocerithium* Monterosato, 1911, *ibid.*, p. 68.)

(*Drillocerithium* Monterosato, 1911, *ibid.*, p. 71.)

(*Hirtocerithium* Monterosato, 1911, *ibid.*, p. 73.)

(*Lithocerithium* Monterosato, 1911, *ibid.*, p. 75.)

Type species (o.d.) *Murex alacastrum* Brocchi — *Cerithium vulgatum* Bruguière.

Subgenus *THERICIUM* s. str.

Theridium (*Theridium*) *fallax* (Ludbrook)

pl. 1, fig. 5.

Terebralia fallax Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 91, pl. 4, fig. 21; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis.—Protoconch of two small globose whorls followed by six convex whorls, very finely and conspicuously cancellate, posterior half more finely cancellate than anterior half of each whorl. Whorls plicate from about sixth whorl, plications about seven per whorl and increasing in prominence anteriorly. Spiral sculpture becomes dominant from seventh whorl and cancellation disappears. In later whorls plications and interspaces crossed by fine spiral threads which are at first rounded and in the later whorls become flattened, each supporting a median striation.

Dimensions.—Height 31, diameter 11.5 mm.

Type Locality.—Abattoirs Bore.

Location of Holotype.—Tate Mus. Coll., Univ. of Adelaide, T 1621.

Observations.—One specimen (pl. 1, fig. 5) complete except for the apex, was recovered from a bore put down on Pecze's property, Section 4251, Hundred of Munno Para, in 1955.

Material—Portions of about 70 paratypes, mainly juveniles, Abattoirs Bore; 6 specimens, Weymouth's Bore; hypotype, Sec. 4251, Hd. Munno Para, at 238 to 256 feet.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Subgenus *CHAVANICERITHIUM* subgen. nov.

Subgeneric Characters—Shell with true varices, generally one strong varix on the body whorl opposite the aperture. Aperture oblique, ovate, with a short, pointed posterior canal and a parietal tubercle below it. Anterior canal oblique and slightly recurved. Columella concave, without plaits, as in *Theridium*. Shell differs from that genus in having the axial sculpture suppressed in the early whorls and developing into convex, rounded axial ribs or folds in the later whorls. Whorls with a subsutural band which commonly interrupts the axial ribs. Outer lip characteristically inflexed. Columella generally with one or two spiral furrows extending on the base below the periphery and visible particularly in younger shells.

Type species *Terebralia adelaidensis* Howchin & Cotton.

***Theridium* (*Chavanicerithium*) *adelaidense* (Howchin & Cotton)**

pl. 1, fig. 3.

Terebralia adelaidensis Howchin & Cotton, 1936, Trans. Roy. Soc. S. Aust., 60, p. 131, pl. 1, figs. 1, 2; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Campanile adelaidensis Howchin & Cotton, Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—Early whorls flat to concave, later whorls convex. Sculpture comparatively fine and inconspicuous in the early whorls with a subsutural band supporting 2 or 3 spiral striae; anterior three-quarters of whorl, which is medially constricted, sculptured with about 8 somewhat irregular spiral cords, some of which are surmounted and divided by spiral striae; interspaces linear, much narrower than cords, and deeper anteriorly so that the cords appear to be imbricating. Whole whorl crossed by concave growth striae and numerous axial costae; costae decrease in number and increase in strength to about 12 on the penultimate whorl. Strong costae in anterior whorls of adult shell are interrupted or effaced posteriorly by a constriction in the posterior third of the whorl.

Dimensions—Height 85, diameter 27 mm.

Type Locality—Glanyille Bore, 375-400 feet.

Location of Holotype—S. Aust. Mus., Reg. No. D 12852.

Description of Hypotype (Hindmarsh Bore, pl. 1, fig. 3)—Shell large, solid, elongate, conical, early whorls flat to concave, later whorls convex. Suture imbricating, undulating in later whorls, straight in early whorls. Sculpture comparatively fine and conspicuous in the early whorls, with a subsutural band, somewhat more than one-quarter width of the whorl, supporting two or three spiral striae, the rest of the whorl, which is medially constricted, sculptured with about eight rather irregular spiral cords, some of which are surmounted and divided by the spiral striae; interspaces linear, much narrower than cords and deeper anteriorly so that the cords appear to be imbricating. Band and cords all crossed concavely by growth striae and by numerous gradually developing axial costae, which tend to tuberculate the spirals. Axial costae decrease in number and increase in intensity to about twelve on the penultimate whorl. In the anterior whorls of the adult shell the strong costae are interrupted or effaced posteriorly by a constriction in the posterior third of the whorl.

Aperture oblique, ovate, with a short, pointed posterior canal and a posterior tubercle below it on the inner lip. Inner lip reflexed over the arcuate columella. Anterior canal short and strongly reflexed with a twist at the anterior end of the columella. Outer lip expanded and slightly produced anteriorly, concave posteriorly, and convex anteriorly in profile. Lip not varicate, but

there is a strong varix on the body whorl between one-half and two-thirds the distance from the outer lip.

Observations—This is one of the most typical and restricted gastropods of the Dry Creek Sands. Its superficial resemblance in shape and sculpture to *Terebralia palustris* Linné, an estuarine Indo-Pacific species, led the original authors to locate it in *Terebralia*. The resemblance, however, is entirely superficial and appears to be a case of homeomorphy; the columella as revealed in crooked specimens lacks the diagnostic plaits of *Terebralia*, while the strong varix on the body whorl identifies the shell with the Cerithiidae. In almost all respects the shell is a typical *Theridium*. However, the sculpture lacks the angulate axial costae of *Theridium* s. str., the early whorls are flatter and the subsutural band is characteristic. The anterior canal is short in the adult but appears longer in the juvenile, is oblique and slightly recurved; the tooth-like tubercle is recognizable only when the aperture is completely preserved, but there are generally one or more strong cords below the periphery on the base, not necessarily related to the tubercle. These are very conspicuous in the tropical *C. (T.) opportunum* and in the Adelaide species.

The subgenus is therefore created, named for Monsieur Andre Chavan of Seyssel, France, who has studied the classification of the Cerithiidae. Into the subgenus fall, in addition to the type species, *Cerithium torri* Tate, *C. pritchardi* Harris, as well as the Indo-Pacific *opportunum* Bayle and the common Italian species *varicosum* Brocchi. The Parisian Eocene *semicostatum* and *filiferum*, both of Deshayes, may possibly belong to the same lineage.

Material—Hypotype and 4 broken specimens, Hindmarsh Bore; 2 specimens, Weymouth's Bore; 1 broken specimen, Kooyonga Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

***Theridium (Chavanicerithium) torri* (Tate)**

pl. 1, figs. 1, 2.

Cerithium torri Tate, 1899, Trans. Roy. Soc. S. Aust., 23 (1), p. 109, pl. 1, fig. 2

Diagnosis—A fairly large *Chavanicerithium* sculptured with conspicuous, distant, raised, moderately oblique, more or less nodulose axial costae, conspicuously interrupted in the posterior of each whorl and continuous in the anterior part of the whorl only, at least on the penultimate whorl. In young shells entire whorl covered with close, irregular spiral striations generally stronger on the costae, and fainter axial growth lines concave to the aperture.

Dimensions—Total estimated length 160 mm., diameter 24 mm.

Type Locality—"Murray Desert"?—Tareena, N.S.W.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 532. Hypotypes, F 15175, F 15176, Tate Mus. Coll.

Observations—Juveniles of this species are difficult to separate from juveniles of *T. (C.) pritchardi* (Harris), and closely resemble the Recent *T. (C.) opportunum* (Bayle). *Cerithium polygonum* Sowerby from Northern Australia. The interruption of the axial costae and their nodulose character in the adult serve to distinguish the species. The holotype is a larger shell than the Dry Creek Sands relatives which attain an estimated total length of between 80 and 90 mm.

Material—Holotype; hypotype and 11 other specimens, Abattoirs Bore; 7 specimens, Bore, Sec. 4251, 11d. Munno Pawa; 1 specimen, Jones's Bore; 5 specimens, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands and unnamed formation, Murray Basin.

Geographical Distribution—Adelaide District; ? Tareena, N.S.W.

Genus SEMIVERTAGUS Cossmann, 1889.

Semivertagus Cossmann, 1889, Ann. Soc. Roy. Mal. Belg., 24, p. 28.

Type species (o.d.) *Cerithium unisulcatum* Lamarck.

Semivertagus capillatus Tate

pl. 2, fig. 9.

Semivertagus capillatus Tate, 1894, Journ. Roy. Soc. N.S.W., 27, p. 178, pl. iii, fig. 1; Demant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 144; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—Twelve whorls in a length of 17 mm. Suture conspicuous, imbricating. Sculpture of about 20 spiral striae per whorl, narrower than interspaces which increase in width towards the anterior suture, crossed by weaker arched growth striae. Columella without plication, anterior canal short, inner lip callous and reflected over columella, with a posterior tubercle.

Dimensions—Height 17, diameter 5 mm.

Type Locality—Dry Creek Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1539c.

Material—Hypotype and 2 specimens, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Genus HYPOTROCHUS Cotton, 1932.

Hypotrochus Cotton, 1932, Rec. S. Aust. Mus., 4 (4), p. 540.

Type species (o.d.) *Cerithium monachus* Crosse & Fischer.

Hypotrochus semiplicatus sp. nov.

pl. 2, fig. 10.

cf. *Hypotrochus penetrivinctus* Cotton, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Hypotrochus penetrivinctus Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—Whorls slightly convex, angulate above the suture; eight adult whorls in a height of 6 mm., sculptured with axial plicae, 9 per whorl, obsolete on the posterior part of the whorl, broadening and increasing in strength towards the anterior suture immediately above which they meet a suprasutural cord which is undulated on its anterior side by the anterior limit of the plicae. Plicae become obsolete on the body whorl. Spiral sculpture of four deep and clear cut striae and the flattish suprasutural cord which is bordered above by the anterior striae and undulated below by the axial plicae on all the whorls but the body whorl where it is represented by a wider band between the striae.

Description of Holotype—Shell small, elongate-conical, surface smooth and rather polished. Whorls slightly convex and angulate above the suture; suture linear, with a tendency to undulate. Apex small and elevated, of two smooth turns, adult whorls eight, of which the first is sculptured with one strong brephic spiral, the next six whorls with nine axial plicae per whorl, obsolete in the posterior part of the whorl, broadening and increasing in strength towards the anterior suture above which they meet a suprasutural cord which is undulated on its anterior side by the lower edge of the plicae. Plicae become obsolete on the body whorl and die out over the whole of the whorl. Spiral sculpture of four fairly deep and clear-cut striae and the suprasutural cord bordered above by the axial plicae on all the whorls but the body whorl, where it is represented by a wider band between the striae. Four evenly-placed striae from the periphery, which is subangular, over the base to the columella. Aperture subovate and oblique, columella gently arched, anterior canal short and turned to the left. Outer lip with a varix behind it.

Dimensions—Height 6, diameter 2, height of body-whorl 2.7, height of aperture 1.5 mm.

Type Locality—Weymouth's Bore, 310-330 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15161.

Observations—This small *Hypotrochus* is distinguishable from the Recent *penetratocinctus* by the absence of keels. There is a suggestion of carination at the cord above the suture, but it can scarcely be described as a keel, and is not present on the body whorl.

Material—Holotype and 12 paratypes, Weymouth's Bore, 18 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's and Abattoirs Bores, Adelaide.

Family CERITHIOPSIDAE.

Genus CERITHIELLA Verrill, 1882.

Cerithiella Verrill, 1882, Trans. Connect. Acad., 5, p. 522.

Type species (o.d.) *Cerithium metula* Lovén.

Subgenus COXELLARIA subgen. nov.

Subgeneric Characters—Shell very small and very elongate, subulate, shining and solid. Whorls flat. Protoconch large and elevated, multispiral, tip heterostrophic, first 2 whorls only partially in contact. Smooth apical whorls followed by one-and-a-half brephic turns with close concavely-curving axials. Adult whorls ornamented with flattish thick spiral ribs which cross and tuberculate the fairly numerous axial ribs. Axial ribs nearly straight, not curved as in *Cerithiella* s. str. Aperture subquadrate, outer lip nearly perpendicular in profile instead of concave as in *Cerithiella* s. str. Anterior canal strongly twisted. Base flat.

Type species *Cerithiella trigemmata* Chapman & Crespin. The subgenus is named in honour of Dr. L. R. Cox of the British Museum (Natural History).

Cerithiella (*Coxellaria*) *trigemmata* Chapman & Crespin

pl. 2, fig. 11.

Cerithiella trigemmata Chapman & Crespin, 1928, Rec. Geol. Surv. Vic., 5 (1), p. 116, pl. 8, fig. 48; Luthbrock, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Crespin, 1943, Aust. Min. Res. Surv. Bull. 9, p. 96 (mimeographed).

Cerithiella (lapsus calami for *Cerithiella*) *trigemmata* Chapman & Crespin, Cotton, 1952, Geol. Surv. S. Aust. Bull. 27, appendix 4, p. 245.

Diagnosis—16 whorls in a height of 8 mm. Protoconch large and elevated, tip pointed and heterostrophic, apical 3 whorls followed by one-and-a-half turns with brephic axials. Adult whorls flat, ornamented with ten straight axial costae per whorl, crossed and tuberculated by three flattish spiral ribs about equal to the interspaces. Interspaces rectangular, smooth. Suture linear, excavate. Aperture subquadrate, outer lip straight and perpendicular in profile.

Dimensions—Height 5.75, diameter 1 mm.

Type Locality—Mitchell River, Victoria; Miocene.

Location of Holotype—Dennant Coll., Nat. Mus., Melbourne.

Observations—For this long-ranging and widespread species and the two succeeding species, the new subgenus *Coxellaria* is created. Compared with the type species, *Cerithiella metula* Lovén from the North Sea, species of *C.* (*Coxellaria*) are different in texture; the whorls are shining and solid and the growth lines are not visible. The whorls are typically flat, the shell is very elongate-subulate. The sculpture is coarser and flatter and not so sharply cancellate as in *Cerithiella* s. str. The axial sculpture of *Cerithiella* is markedly curved; it is straight or nearly so in *Coxellaria*. The protoconch is large, resembling some members of *Triphora*. The subgenus is related to or includes two species from the Paris Basin Eocene, *Cerithiella clava* Lamarck and *C. multispinata* Deshayes. In addition to the type species, the subgenus is represented by one closely re-

lated species, and one in which the spiral sculpture is absent, from Brown Coal Shaft, Altona, Victoria, in the British Museum Collection.

Material—5 specimens, Abattoirs Bore; 2 specimens, Brown Coal Shaft, Altona, Victoria, B.M. Coll.

Stratigraphical Range—"Tertiary".

Geographical Distribution—Gippsland, Vic., to Adelaide, S.A.

***Cerithiella (Coxellaria) perelongata* (Ludbrook)**

Cerithopsis perelongatus Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 90, pl. 4, fig. 25 (in part).

Diagnosis—Protoconch elevated, three carinate, large, smooth, tapering whorls; tip heterostrophic. Adult whorls 8 in a height of 6 mm., flattened, sculptured with three equal spiral costae crossed by about 16 axial costae per whorl less conspicuous than the spirals which are flatly gemmulate at the intersections. At first the whorls are carinate at the anterior but rapidly flatten. The median spiral tends to be more gemmulate than the anterior and posterior which are flattened.

Dimensions—Height 6.1, diameter 1.1 mm.

Type Locality—Abattoirs Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T1651.

Observations—One perfect specimen was obtained from Weymouth's Bore. The elevated protoconch with a large second whorl, strongly carinate, and a smaller third whorl is followed by adult whorls at first carinate near the suture at the position of the anterior of the three spiral ribs.

The suture and interspaces are linear, in the later whorls the suture being distinguishable from the interspaces between the spirals only by being more excavate.

Material—Holotype and 2 paratypes, Abattoirs Bore; 2 specimens, one perfect, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide.

***Cerithiella (Coxellaria) superspiralis* sp. nov.**

pl. 2, fig. 12.

Cerithopsis perelongatus Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 90 (in part).

Diagnosis—Shell large for the subgenus and extremely elongate. Sculpture on the flat whorls of about 18 relatively inconspicuous axial ribs crossed by three strong spirals of which the anterior and median are narrower and more roundly gemmulate at the junctions with axials, the posterior broader and flatter and only obsoletely gemmulate.

Description of Holotype—Shell incomplete, early whorls missing, nine adult whorls remaining; large for the subgenus, solid, very elongate-subulate. Whorls flat, suture linear, and inconspicuous unless viewed from the apex towards the aperture, when it is seen to be imbricated by the posterior spiral rib. Whorls sculptured with numerous axial ribs, eighteen on the penultimate whorl, crossed by three strong spirals with two equal interspaces between them. The anterior and median spirals are narrower than the posterior and are more distinctly and roundly gemmulate. The posterior rib borders the suture, is flat and only obsoletely gemmulate. All the ribs are steeply terminated on the posterior side and gently slope anteriorly. The contrast is shown by viewing from apex to aperture. Aperture broken, outer lip indeterminable, columella concave; remains of anterior canal shown by twist at the end of the columella. Base flat, smooth except for concave axial growth striae crowding in towards the columella. Periphery angulate with two smooth cords.

Dimensions—Length of 9 whorls 8.5, diameter 2.5; total estimated length 12 mm. or greater.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15162.

Observations—In the original description of *Cerithiopsis perelongatus* (Ludbrook, 1941, p. 90) a paratype was cited as a much larger shell with sculpture consistent with that of the holotype. The two specimens of *perelongatus* from Weymouth's Bore have now enabled the species to be more accurately diagnosed, and it is realised that the large specimen is not conspecific with *perelongatus*. The sculpture is not, as stated previously, consistent with that of *perelongatus*.

Material—Holotype only.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Genus *SEILA* A. Adams, 1861.

Seila A. Adams, 1861, Ann. Mag. Nat. Hist., ser. 3, 7, p. 131.

Type species (s.d. Dall, 1889) *Triphoris dextroversa* Adams & Reeve.

Subgenus *NOTOSEILA* Finlay, 1927.

Notoseila Finlay, 1927, Trans. N.Z. Inst., 57, p. 382.

Type species (o.d.) *Cerithium terebelloides* Hutton.

Seila (*Notoseila*) *triplanicincta* sp. nov.

pl. 2, figs. 13, 14.

Seila (*Notoseila*) *crocea* Angas, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—Shell very elongate-subulate, with a total of 15 whorls in a height of 12 mm. Sculptured with three flat equal spiral ribs on each whorl, approximately equal to the interspaces. Ribs smooth, with flat upper surface and sides at right angles to the upper surface. Interspaces flat, marked by axial growth lines. Suture linear or marked by a fine thread.

Description of Holotype—Shell of moderate size for the genus, very elongate-subulate. Protoconch large and elevated, tip broken but 2 whorls remaining, smooth and convex. Adult whorls flat, gradually increasing, sculptured with three flat spirals on each whorl of equal size and approximately equal to the interspaces. Upper surface of ribs smooth and flat, sides at right angles to the upper surface. Interspaces crossed by fine axial striae of growth. Suture imperceptible but indicated by a fine spiral line. Aperture broken in the holotype. Columella concave, with a very strongly recurved short anterior canal.

Dimensions—Height 12, diameter 2 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15163.

Paratype—A portion of a specimen consisting of the body and penultimate whorls shows the aperture as subquadrate with the outer lip perpendicular when viewed in profile. The base is flat and smooth, except for 2 lirae, finer than the spiral ribs, on the angulate periphery.

Observations—*S. (N.) triplanicincta* is not conspecific with *S. (N.) crocea*. The ribs are quite flat, the whorls are not at all convex except for the protoconch, and the shell is more attenuated.

Material—Holotype, Abattoirs Bore; 2 paratypes, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Hindmarsh Bores, Adelaide.

Family *TRIPHORIDAE*,

Genus *TRIPHORA* Blainville, 1828.

Triphora Blainville, 1828, Dict. Sci. Nat., 55, p. 344.

Type species (o.d.) *Triphora gemmata* Blainville.

Subgenus *ISOTRIPHORA* Cotton & Godfrey, 1931.

Isotriphora Cotton & Godfrey, 1931, S. Aust. Nat., 12 (4), p. 52.

Type species (o.d.) *Triphora tasmanica* = *Triforis tasmanica* Tenison-Woods.

Triphora (Isotriphora) salisburyensis sp. nov.

pl. 2, fig. 15.

Triphora sp. Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 92.

Diagnosis—Protoconch of 3 gemmulate whorls, blunt at tip. Adult whorls 11, making a total of 14 whorls in a height of 7 mm. First two adult whorls with two rows of granules; on the third whorl a thread rises between them and gradually develops into a third row of granules. The granules are produced at the intersection of the axials by three equal spirals, which are steeply terminated on their sides, and the interspaces tend to be rhombic. Suture canaliculate. Base with two keels, one on the periphery and one less than halfway between it and the base of the columella.

Description of Holotype—Protoconch broken. Adult whorls ten, of which the first two have two rows of granules. On the third a thread rises between them and gradually develops into a third row of granules. These granules are produced at the points of intersection of the radial costae, about 20 per whorl, and the three equal spirals which override the axials. Spirals steeply cut off on their sides, interspaces tending to be rhombic. Suture linear, deeply set in a channel between two rows of granules. Base smooth except for axial growth lines with two keels, one on the periphery and one less than halfway between the periphery and the base of the columella. Outer lip, when viewed in profile, is at first convex then nearly straight, effuse at the base and upcurved to meet the base of the columella. Anterior canal strongly retroflexed and almost cylindrical.

Dimensions—Height 7, diameter 1.5 mm.

Type Locality—Weymouth's Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15164.

Observations—Compared with the type species of the subgenus, *T. (I.) tasmanica*, the present species is smaller and more attenuated. There are 14 whorls in a height of 7 mm. as contrasted with 18 whorls in a height of 9 mm. in *tasmanica*. The sharp termination of the edges of the spirals is distinctive, together with the disposition of the keels on the base.

Material—Holotype and paratype, Weymouth's Bore; one fragment, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bores, Adelaide.

Subgenus *NOTOSINISTER* Finlay, 1927.

Notosinister Finlay, 1927, Trans. N.Z. Inst., 57, p. 384.

Type species (o.d.) *Triphora fascelina* Suter.

Triphora (Notosinister) praegranifera sp. nov.

pl. 2, fig. 16.

Triphora sp. Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 92.

Diagnosis—A *Notosinister* with protoconch of two smooth turns followed by three turns carinate in the anterior one-third; adult whorls nine making total of 14 whorls in a height of 4.4 mm. First four whorls sculptured with 2 rows of about 16 granules per whorl, a third row developing between them at the fifth whorl. Suture linear, inconspicuous. Base smooth, with three spiral cords.

Description of Holotype—Shell elongate-turreted, solid, somewhat pupiform. Protoconch large, elevated, polygyrate, of two smooth turns followed by three turns carinate in the anterior one-third and carrying about 20 brepheic axials per whorl. Adult whorls 9, of which the first four are sculptured with

two rows of about 16 granules per whorl, a third row rising between them at the fifth whorl and increasing gradually in strength until on the last whorl there are three approximately equal rows, the posterior being somewhat stronger than the other two. Suture inconspicuous, linear. Base smooth with three spiral cords. Outer lip broken in the holotype.

Dimensions—Height 4.4, diameter 1.5 mm.

Type Locality—Weymouth's Bore, 310-330 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15165.

Observations—*T. (N.) granifera* Brazier appears to be the nearest relative to the present species.

Material—Holotype and one paratype, Weymouth's Bore; 13 paratypes, mostly broken, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's and Abattoirs Bores, Adelaide.

Superfamily SCALACEA.

Family SCALIDAE.

Genus AMAEA H. & A. Adams, 1853.

Amaea H. & A. Adams, 1853, Gen. Rec. Moll., 1, p. 223.

Type species (s.d. Fischer, 1885) *Scalaria magnifica* Sowerby.

Subgenus AMAEA s. str.

Amaea (Amaea) triplicata (Tate)

pl. 3, fig. 1.

Scalaria (Eglisia) triplicata Tate, 1890, Trans. Roy. Soc. S. Aust., 13 (2), p. 231.

Scalaria triplicata Tate, 1892, *id.*, Supp. pl. 9, fig. 2.

Eglisia triplicata Tate, Harris, 1897, Cat. Tert. Moll. Brit. Mus., 1, p. 270; Demant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 138; Lindbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—An *Amaea* with 15 whorls in a height of 28 mm. Sculptured with about 25 thin, more or less elevated costae per whorl, which are curved forward and decurrent at the posterior suture; axials either crossed by or crossing three prominent elevated rounded spiral cords which are a little to the anterior of the whorl. Body whorl with four strong spiral cords, one on the periphery. Base with about 10 spiral lirae crossed by fine radials corresponding to the axial costae on the whorls.

Dimensions—Height 28, diameter 7, height and width of aperture 5 mm.

Type Locality—Muddy Creek, Victoria; Pliocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 790D.

Observations—The species *triplicata* belongs to *Amaea* s. str. which is restricted to the Indo-Pacific in Recent times, the nearest species to the fossil being *A. kieneri* (Canefri) from Darnley Island. The varix on the outer lip, cited by Wenz (1940, p. 804) as a generic character is not diagnostic as it is frequently absent altogether. *A. triplicata* has also been recorded from Abattoirs and Croydon Bores.

Material—One broken specimen, Hindmarsh Bore.

Stratigraphical Range—Kalinna to Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria, to Adelaide. S.A.

Amaea (Amaea) sp.

A single broken specimen, congeneric with *triplicata*, occurs in Hindmarsh Bore, with four sharp and narrow equal spiral cords and a smaller posterior cord, crossed by about 24 axial costae per whorl. Sufficient material is not available for comparison and accurate diagnosis. The number and character of the spiral cords distinguish the specimen from *triplicata*.

Genus *CIRSOTREMA* Mörch, 1852.

Cirsotrema Mörch, 1852, Cat. Conchyliol., 1, p. 49.

Type species (monotypy) *Scalaria varicosum* Lamarck.

Subgenus *DANNEVIGENA* Iredale, 1936.

Dannevigena Iredale, 1936, Rec. Aust. Mus., 19, p. 303.

Type species (o.d.) *Dannevigena martyr* Iredale.

Cirsotrema (*Dannevigena*) sp.

A fragment of a *Dannevigena*, consisting of most of the body whorl and portion of the penultimate whorl. The species appears to be very close to the type species *Dannevigena martyr* Iredale. The genus, so far as is known, is restricted to southern Australia.

Material—One broken specimen, Weymouth's Bore.

Genus *SCALA* Bruguière, 1792.

Scala Bruguière, 1792, Encyc. méth. Vers., 1 (2), p. 532.

(*Epitonium* Röding, 1798, Mus. Bolt., 2, p. 91.)

(*Cyclostoma* Lamarck, 1799, Mem. Soc. Hist. nat. Paris, p. 74.)

(*Scalaria* Lamarck, 1801, Syst. Anim., p. 88.)

(*Scalaris* Montfort, 1810, Conch. Syst., 2, p. 294.)

(*Actoni* Leach, 1815, Zool. Miscell., 2, p. 79.)

Scala Bruguière, 1792, Wenz, 1940, Handb. Paläoz. Gastr., 4, p. 806 (synonymy).

Type species (s.d. Thiele, 1929) *Turbo scalaris* Linné.

Subgenus *HIRTOSCALA* Monterosato, 1890.

Hirtoscala Monterosato, 1890, Natur. Sicil., 9, p. 149.

(*Linctoscala* Monterosato, 1890, *ibid.*)

(*Foveoscala* Boury, 1909, Journ. de Conch., 57, p. 257.)

(*Acutiscala* Boury, 1909, *ibid.*)

(*Prudentiscala* Iredale, 1936, Rec. Aust. Mus., 19, p. 299.)

Hirtoscala Monterosato, 1890, Wenz, 1940, Handb. Paläoz. Gast., 4, p. 808 (synonymy).

Type species (o.d.) *Scalaria cantrainaei* Weinkauff.

Scala (*Hirtoscala*) sp.

Diagnosis—A small *Hirtoscala* with a large and elevated protoconch of three globose turns. Adult whorls sculptured with about 14 elevated oblique axial ribs per whorl, somewhat extended and angulate posteriorly. Interspaces smooth. Suture deep. Aperture subovate, entire; outer lip without varix.

Observations—In view of the fact that only one juvenile specimen is available of this apparently new species, it is not here described in full. The first whorl of the apex is missing, there are 2 subsequent globose embryonic whorls and three adult whorls. The species is closest to *S. (H.) delicatula* (Crosse & Fischer), Recent, South Australia, from which it differs by comparison with the holotype in the British Museum, in having a larger protoconch and fewer axials in the early whorls.

Both the present species and *delicatula* are readily comparable with *cantrainaei*, the type species of *Hirtoscala* with which *Acutiscala* is considered by Wenz (1940, p. 808) to be synonymous. The South Australian species are closer to *cantrainaei* than to *philippinarum* Sowerby, the type species of *Acutiscala*. The subgenus *Hirtoscala* appears to have a wide distribution in warm seas.

Material—One juvenile, with broken tip, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's Bore, 310-330 feet.

Superfamily PYRAMIDELIACEA.

Family MELANELLIDAE.

Genus *MELANELLA* Bowdich, 1822.

Melanella Bowdich, 1822, *Elem. Conch.*, 1, p. 27.

(*Melaniella* P. Fischer, 1887, *Journ. de Conch.*, 35, p. 198, non L. Pfeiffer, 1857.)

Type species (monotypy) *Melanella dufresnii* Bowdich ? = *Eulima arcuata* Sowerby.

Subgenus *MARGINEULIMA* Cossmann, 1888.

Margineulima Cossmann, 1888, *Ann. Soc. Malac. Belg.*, 23, Mem. p. 117.

Type species (o.d.) *Eulima fallax* Deshayes.

Melanella (*Margineulima*) *longiconica* (Ludbrook)

Eulima longiconica Ludbrook, 1941, *Trans. Roy. Soc. S. Aust.*, 65 (1), p. 93, pl. 5, fig. 4; Crespin, 1943, *Min. Res. Surv. Bull.* 9, p. 95.

Diagnosis—A small *Margineulima* with protoconch of one inconspicuous flattened turn and eight slowly decreasing adult whorls in a height of 5 mm. Suture slightly impressed.

Dimensions—Height 5, diameter 2 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1634.

Material—Holotype.

Stratigraphical Range—Kalimnan (Jemmy's Point Formation)—Dry Creek Sands.

Geographical Distribution—Gippsland, Vic., and Adelaide, S.A.

Melanella (*Margineulima*) *minuticonica* (Ludbrook)

Eulima minuticonica Ludbrook, 1941, *Trans. Roy. Soc. S. Aust.*, 65 (1), p. 93, pl. 5, fig. 5.

Diagnosis—A minute *Margineulima* with protoconch consisting of two conspicuous turns followed by 7 adult whorls in a height of 3.1 mm. Body whorl with an obscure angulation. Aperture pyriform.

Dimensions—Height 3.1, diameter 1.0 mm.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1634.

Observations—No further examples of this species have been recovered since it was described from Abattoirs Bore. The subgenus is represented in the European Eocene-Miocene, and has lingered till recent times in Australia and the Indo-Pacific. *M. (M.) roegerae* is the closest ally in South Australia.

Material—Holotype and 5 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore.

GENUS *LEIOSTRACA* H. & A. Adams, 1853.

Leiostraca H. & A. Adams, 1853, *Gen. Rec. Moll.*, 1, p. 237.

Type species (s.d. Suter, 1913) *Turbo subulata* Donovan = *Strombiformis glabra* Da Costa.

Subgenus *LEIOSTRACA* s. str.

Leiostraca (*Leiostraca*) *acutissima* Sowerby

pl. 3, fig. 2.

Leiostraca acutissima Sowerby, 1860, in Reeve *Conch. Icon.*, 15, *Leiostraca* sp. 10, pl. 2, fig. 10a, b; Hedley, 1913, *Proc. Linn. Soc. N.S.W.*, 38, p. 295.

Leiostraca lesbia Angus, 1871, *Proc. Zool. Soc.*, p. 16, pl. 1, fig. 14.

Strombiformis acutissima Sowerby, Hedley, 1918, *Journ. Roy. Soc. N.S.W.*, 51, supp. p. 100; Cotton & Godfrey, 1938, *Mal. Soc. S. Aust.*, Pub. 1.

Diagnosis—Shell very small and acuminate, 8 whorls in a height of 8 mm.; last whorl one half height of shell. Aperture narrow, sharply angled posteriorly; columella long and straight.

Dimensions—Height 8, diameter 1.5, height of body whorl 4, height of aperture 2 mm.

Type Locality—Sydney Harbour; Recent.

Location of Holotype—B.M. Coll.

Observations—Compared with the holotype, the fossil from the Adelaide Pliocene is a little more slender.

Material—Holotype, one specimen Muddy Creek (Upper), one specimen Altena Coal Shaft, all B.M. Coll.; one specimen and one fragment, Hindmarsh Bore.

Stratigraphical Range—Balcombian to Recent.

Geographical Distribution—N.S.W. and southern Australia.

Genus *Niso* Risso, 1826.

Niso Risso, 1826, Hist. Nat. Europe Merid., 4, p. 218.

(*Bonellia* Deshayes, 1838, in Lamarek Hist. Nat. Anim. s. Vert., ed. 2, 8, p. 286, non Rolando, 1823.)

(*Janella* Grateloup, 1838, Act. Soc. Linn. Bordeaux, 10 (52), p. 191.)

Type species (monotypy) *Niso eburnea* Risso.

Subgenus *Niso* s. str.

Niso (*Niso*) *psila* Tenison-Woods

pl. 3, fig. 3.

Niso psila Tenison-Woods, 1880, Proc. Linn. Soc. N.S.W., 4, p. 18, pl. 1, fig. 6; Tate & Dennant, 1893, Trans. Roy. Soc. S. Aust., 17 (1), p. 222; Harris, 1897, Cat. Tert. Moll. Brit. Mus., 1, p. 272; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), pp. 115, 138; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A *Niso* of moderate size, height a little less than three times diameter. Protoconch of $1\frac{1}{2}$ rather high dome-shaped turns followed by 8 narrow flatly increasing adult whorls in a height of 8 mm. Suture linear; impressed. Periphery roundly angulate, umbilicus keeled at the margin. Aperture angulate in front.

Dimensions—Height 7, diameter 3 mm.

Type Locality—Muddy Creek, Victoria.

Location of Holotype—Aust. Mus., Sydney, F 1708.

Observations—Of the scanty material available Adelaide examples appear all to be small; a maximum height of about 13 mm. is indicated. The holotype is apparently juvenile; adult specimens reach a height of over 20 mm.

Material—1 juvenile, 1 incomplete example, Abattoirs Bore; 1 ephebic specimen, Weymouth's Bore.

Stratigraphical Range—Balcombian to Dry Creek Sands.

Geographical Distribution—Gippsland, Vic.-Adelaide, S.A.

Family PYRAMIDELLIDAE.

Genus *SYRNOLA*. A. Adams, 1860.

Syrnola A. Adams, 1860, Ann. Mag. Nat. Hist., ser. 3, 5, p. 405.

Type species (monotypy) *Syrnola gracillima* A. Adams.

Subgenus *SYRNOLA* s. str.

Syrnola (*Syrnola*) *tincta* Angas

pl. 3, fig. 4.

Syrnola tincta Angas, 1871, Proc. Zool. Soc., p. 15, pl. 1, fig. 11; Hedley, 1918, Journ. Roy. Soc. N.S.W., 51, supp. p. 98; May, 1921, Check List, p. 98; Ill. Ind., p. 93, pl. 44, fig. 14; Chapman, Crespin & Koble, 1928, Rec. Geol. Surv. Vic., 5 (1), p. 161; Cotton & Godfrey, 1932, S. Aust. Nat., 14 (1), p. 22; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Syrnola michaeli Tenison-Woods, 1877, Proc. Roy. Soc. Tas. for 1876, p. 150.

Diagnosis—A rather solid *Syrnola*, whorls 10, in a height of 6 mm. nearly flat with deeply impressed suture. Protoconch heterostrophic, elevated, early whorls relatively large, body whorl fairly small, subangulate at the periphery.

Dimensions—Height 6, diameter 1 mm.

Type Locality—Off Sow and Pigs Reef, Port Jackson, N.S.W.; Recent.

Location of Holotype—B.M. Coll.

Observations—Except for its occurrence in Abattoirs Bore, only one specimen, a small one of length 3.5 mm. and here figured as hypotype, has been found in the Dry Creek Sands. It has been recorded from the Balcombian of the Sorrento Bore (Chapman, Crespin & Koble, 1928, p. 161). The record needs confirmation.

Material—Hypotype, Weymouth's Bore, 310-330 feet; 3 specimens, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands to Recent; (?) Balcombian.

Geographical Distribution—New South Wales to Rottnest Island, Western Australia.

Subgenus *AGATHA* A. Adams, 1860.

Agatha, A. Adams, 1860, Ann. Mag. Nat. Hist., ser. 3, 6, p. 422.

(*Amathis*, A. Adams, 1861, *id.*, 8, p. 303.)

Type species (monotypy) *Agatha virgo* A. Adams.

Syrnola (*Agatha*) *prae fasciata* sp. nov.

pl. 3, fig. 5.

Syrnola bifasciata T. Woods, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—An *Agatha* of moderate size, spire relatively short, body whorl large, more than half height of shell, evenly convex from posterior suture over periphery and base. Aperture elongate-ovate.

Description of Holotype—Shell of moderate size for the genus, spire relatively short, whorls four, outlines convex. Protoconch heterostrophic, paucispiral, coiled in a low helicoid spiral. Nucleus small and about one-third immersed. Adult whorls five, smooth but for axial growth striae, convex; suture strong, linear, impressed. Body whorl large, more than half height of shell, evenly convex from posterior suture over periphery and base. Aperture elongate-ovate, not expanded anteriorly; outer lip gently concave, somewhat oblique in profile, slightly incurved at posterior angle before attachment to previous whorl. Columella slightly oblique, nearly straight, plait small but distinct and situated about one-third of length from insertion. Base depressed near columella, leading to narrow umbilicus.

Dimensions—Height 5.5, diameter 2.5, height of body whorl 3.5, height of aperture 1.8 mm.

Type Locality—Weymouth's Bore, 310-330 feet.

Location of Holotype—Tate Mus. Coll., F 15166.

Observations—Compared with *bifasciata* with which it was previously identified, the present fossil species has fewer whorls; the body whorl is much longer (in *bifasciata* it is less than one-third height of shell); the aperture is narrower and more elongate and the posterior angle is not acute as in *bifasciata* but joins the previous whorl with a slight inward curve. There is a very close resemblance between *prae fasciata* and the type species, *A. virgo*, which has a small protoconch almost entirely immersed. The subgenus is confined to the Pacific, and is well represented in the New Zealand Tertiary (Laws, 1940, pp. 150-153). The genus *Agatha* was introduced monotypically by Adams for *Agatha virgo*, which he later (Ann. Mag. Ser. 3, 7, p. 295) transferred to *Myonia* (introduced prior to *Agatha* and preoccupied by Dana) then (*ibid.*) to *Menesthis*, again (Ann. Mag. ser. 3, 8, p. 112) to *Myonia*, finally (*id.* 8, p. 304) erecting the genus *Amathis*, naming *Myonia virgo* as type. *Amathis* is thus a direct synonym of *Agatha*, but although *A. virgo* has been referred to *Myonia* which was changed to *Adelactacon* by Cossmann (1895, 1, p. 54) *Myonia* and *Adelactacon* are not synonyms of *Agatha*. They were introduced for a different group of shells and are considered by Wenz (1940, p. 850) to be synonymous with *Actaeopyramis* P. Fischer, 1885.

Material—Holotype and 2 paratypes, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs and Weymouth's Bore.

***Syrnola (Agatha) jonesiana* (Tate)**

pl. 3, fig. 6.

Odontostomia jonesiana Tate, 1898a, Trans. Roy. Soc. S. Aust., 22 (1), p. 70.

Odontostomia (Syrnola) jonesiana Tate, 1898b, *id.*, (2), p. 83, text fig.

Pyramidella jonesiana Tate, Chapman, Crespin & Kehle, 1928, Rec. Geol. Surv. Vic., 5 (1), p. 161.

Syrnola jonesiana Tate, Cotton & Godfrey, 1932, S. Aust. Nat., 14 (1), p. 23; 1938, Mal. Soc. S. Aust., 1, p. 17.

Diagnosis—A small *Agatha* with eight whorls in a height of 6 mm., flat and of moderate width. Suture linear, impressed; base regularly convex; body whorl less than half height of shell, subangulate at the periphery. Columella plait strong and elevated.

Dimensions—Height 6.25, diameter 2.0 mm.

Type Locality—Tintinnarra Bore, 26-154 feet.

Location of Holotype—S. Aust. Mus., D 13466.

Material—One specimen, Weymouth's Bore.

Stratigraphical Range—(?) Mid-Tertiary to Recent.

Geographical Distribution—Port Phillip Bay, Victoria-Adelaide, S. Aust.

***Syrnola (Agatha) infrasulcata* (Tate)**

pl. 3, fig. 7.

Odontostomia (Syrnola) infrasulcata Tate, 1898b, Trans. Roy. Soc. S. Aust., 22 (2), p. 83, pl. 4, fig. 5.

Syrnola infrasulcata Tate, Cotton & Godfrey, 1932, S. Aust. Nat., 14 (1), p. 22; 1938, Mal. Soc. S. Aust., 1, p. 17; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—An *Agatha* of moderate size, with nine whorls in a height of 11 mm. Body whorl subangulate at the periphery, nearly half height of shell, sculptured with about six incised grooves below the periphery and sometimes one or more above the periphery continuing medially on the spire whorls.

Dimensions—Height 11, diameter 3.5 mm.

Type Locality—Holdfast Bay, S. Aust.

Location of Holotype—S. Aust. Mus., Reg. No. D 13465.

Material—The figured hypotype, Weymouth's Bore; one specimen, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands to Recent.

Geographical Distribution—Beachport to Spencer Gulf, S. Aust.

Subgenus PUPOSYRNOLA Cossmann, 1921.

Puposyrnola Cossmann, 1921, Ess. Paleconch., 12, p. 229.

Type species (o.d.) *Auricula acicula* Lamarck.

***Syrnola (Puposyrnola) tasmanica* (Tenison Woods)**

pl. 3, fig. 8.

Styloptygma tasmanica Tenison Woods, 1877, Proc. Roy. Soc. Tas., 1876, p. 151.

Syrnola tasmanica Tenison Woods, May, 1921, Check List, p. 98; Ill. Ind., p. 93, pl. 44, fig. 13; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Crespin, 1943, Aust. Min. Res. Surv. Bull. 9, p. 98.

Diagnosis—A somewhat elongate *Puposyrnola* with 7 adult whorls in a height of 4 mm.; whorls rather tumid, obsoletely striate. Suture almost horizontal, impressed.

Dimensions—Height 4, diameter 1 mm.

Type Locality—Blackman's Bay, Tasmania; Recent.

Location of Holotype—Hobart Museum.

Observations—No further examples of this species have been recovered since it was recorded from Abattoirs Bore. It has been recorded from the Kalimuan of Gippsland (Crespin, 1943, p. 98) and a specimen from the Kalim-

nan of Muddy Creek, Victoria, in the British Museum collection, here figured (pl. 3, fig. 8) is referred to *tasmanica* by comparison with the figure of *tasmanica* (May, 1923, p. 44, fig. 13). No authentic specimens of *tasmanica* have been available for comparison. It is rare in Tasmania and the fossil species may possibly not be identical although it agrees in size and general features.

Material—One specimen, hypotype, Muddy Creek, Vic.; B.M. Coll.

Stratigraphical Range—Kalinman-Recent.

Geographical Distribution—Recent, Tasmania; Tertiary, Gippsland, Vic.; Adelaide, S. Aust.

Syrnola (Puposyrnola) acrisecta Ludbrook

Syrnola acrisecta Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 92, pl. 5, fig. 2.

Diagnosis—A very small *Puposyrnola* sharply pupiform, with six adult whorls in a height of 3.3 mm. Fairly broad with flattened whorls separated by channelled and impressed suture. Body whorl flat above the periphery which is subangulate. Aperture elongate, pyriform, columella nearly straight with a small fold near the origin.

Dimensions—Height 3.3, diameter 1.1 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1637.

Observations—*S. (P.) acrisecta* is the most commonly occurring *Syrnolid* in the Dry Creek Sands, although like other members of the genus it is not numerous. The subgenus *Puposyrnola* is well represented in the New Zealand Tertiary (Laws, 1937, pp. 307-309) although New Zealand species are all very strongly pupiform. The species *acrisecta* is more like the Paris Basin type species *S. (P.) acicula* than the New Zealand species.

Material—Four specimens, Weymouth's Bore; one specimen, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide district.

Subgenus *EVELYNELLA* LAWS, 1940.

Evelynella Laws, 1940, Trans. Roy. Soc. N.Z., 70 (2), p. 153.

Type species (c.d.) *Evelynella venustus* Laws.

Syrnola (Evelynella) adelaidensis sp. nov.

pl. 3, fig. 9.

Diagnosis—A fairly large *Evelynella* with six adult whorls in a height of 4.8 mm. Whorls flatly convex, fairly wide with linear, impressed suture. Body whorl nearly half height of shell, subangulate at periphery. Outer lip arcuate with several lirations deeply within.

Description of Holotype—Shell fairly large for the genus solid, conical, smooth except for faint axial growth striae, shining. Protoconch small, of about 1½ turns, heterostrophic, tip immersed. Adult whorls six, flatly convex, fairly wide; suture linear, impressed. Body whorl large, nearly half height of shell, subangulate at the periphery, flatly convex above the periphery, base convex below and angulate above. Columella vertical, arcuate, with a strong horizontal plait near the origin. Outer lip thin, straight when viewed in profile, arcuate, with about ten lirations deeply within visible only in reflected light.

Dimensions—Height 4.8, diameter 2, height of body whorl 2 mm.

Type Locality—Hindmarsh Bore, 450-487 feet.

Location of Holotype—Tate Mus. Coll., F 15167.

Observations—It is interesting to find this New Zealand Tertiary subgenus among Adelaide specimens. As Laws points out in his diagnosis of the genus

(1940, p. 153), the form of the body whorl with somewhat disproportionate width of the aperture in addition to the very characteristic lirae within the outer lip, serve to distinguish the subgenus from other Syrnelids.

Material—Holotype, Hindmarsh Bore; 2 paratypes, one broken, one juvenile, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Weymouth's Bores, Adelaide.

Genus *TURBONILLA* Risso, 1826.

Turbonilla Risso, 1826, Hist. Nat. Europe merid., 4, p. 224.

Type species (s.d. Dall & Bartsch, 1909) *Turbonilla typica* Dall & Bartsch —
T. plicatula Risso non. Brocchi.

Subgenus *TURBONILLA* s. str.

Turbonilla (*Turbonilla*) *mariae* Tenison Woods

pl. 3, fig. 10.

Turbonilla mariae Tenison Woods, 1876, Proc. Roy. Soc. Tas., 1875, p. 144; May, 1921, Check List, p. 99; May, 1923, Ill. Ind., p. 93, pl. 44, fig. 29; Cotton & Godfrey, 1932, S. Aust. Nat., 14 (1), p. 30.

Turbonilla cf. *mariae* T. Woods, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A *Turbonilla* with a large protoconch of $1\frac{1}{2}$ heterostrophic turns followed by one-half turn with brephic axials. Twelve whorls in a height of 10 mm, with 16 axial ribs on the penultimate whorl. Ribs become obsolete on the periphery but the interspaces are not abruptly terminated at the periphery. Base smooth.

Dimensions—Height 10, diameter 2 mm.

Type Locality—King Island, Bass Strait; Recent.

Location of Holotype—Hobart Museum, Tasmania.

Observations—Adelaide specimens are conspecific with specimens of *T. mariae* from Tasmania in the British Museum. All of these specimens are small as compared with the holotype, and have 10 adult whorls in a height of 7 mm.

Material—Three specimens, one juvenile, Hindmarsh Bore; four specimens, Recent, Tasmania, B.M. Coll.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Tasmania to MacDonald Bay, S. Aust.

Turbonilla (*Turbonilla*) sp.

An immature *Turbonilla* with a large protoconch and 3 adult whorls more finely sculptured than *T. (T.) mariae*.

Material—One specimen, Weymouth's Bore.

Subgenus *CHEMNITZIA* d'Orbigny, 1839.

Chemnitzia d'Orbigny, 1839, in Webb & Berthelot Hist. Nat. Canaries, p. 77.

Type species (monotypy) *Melaniella campanellae* Philippi

Turbonilla (*Chemnitzia*) *mappingae* sp. nov.

pl. 3, fig. 11.

Diagnosis—A *Chemnitzia* of moderate size, stout and thick with nine adult whorls in a height of 5.25 mm., shouldered at the posterior summit and slightly medially depressed. Sculptured with strong axial ribs, 13 on the first and second whorls, 14 on the succeeding whorls. Ribs practically continuous from whorl to whorl.

Description of Holotype—Shell of moderate size, elongate-conical, stout and thick. Protoconch missing, adult whorls nine in a height of 5.25 mm.; whorls shouldered at the posterior summit, somewhat contracted at the periphery, and slightly medially depressed. Sculpture of strong axial ribs, slightly narrower than the interspaces increasing from 13 on the first and second whorls to 14 on

the succeeding whorls; ribs practically continuous from whorl to whorl. Intercostal spaces wider than ribs, fairly deeply sunk and abruptly terminated on the periphery. Base short only slightly rounded; aperture small, broken in the holotype, but apparently subquadrate. Columella short, straight, slightly oblique.

Dimensions—Height 5.25, diameter 1.5, height of body whorl, 1.8 mm.

Type Locality—Weymouth's Bore, Adelaide, 310-330 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15168.

Material—Holotype and last 3 whorls of one paratype, a larger shell than the holotype, Weymouth's Bore; paratype, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Weymouth's and Abattoirs Bores.

Turbonilla (Chemnitzia) wurongae sp. nov.

pl. 3, fig. 12.

Diagnosis—A slowly tapering *Chemnitzia* with eight adult whorls in a height of 6.2 mm. Whorls flat to slightly convex, sculptured with 12 axial ribs per whorl, 14 on the body whorl; intercostal spaces much narrower than ribs, elongate triangular with apex at the posterior extremity and not very deep. Aperture subquadrate; outer lip vertical, columella straight, vertical.

Description of Holotype—Shell of moderate size, elongate. Conical, slowly tapering, stout and thick. Protoconch missing, adult whorls 8 in a height of 6.2 mm. Whorls flat to slightly convex, suture linear, impressed. Sculpture of 12 flatly rounded axial ribs per whorl, 14 on the body whorl. Intercostal spaces much narrower than ribs, elongate-triangular with apex at the posterior extremity, and not very deep, terminated abruptly just above the periphery. Base smooth, of moderate height, slightly rounded. Aperture subquadrate; outer lip vertical, columella straight, vertical.

Dimensions—Height, 6.2, diameter 1.5, height of body whorl 1.35 mm.

Type Locality—Hindmarsh Bore, 450-487 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15169.

Observations—This species is distinguishable from the previous species, *T. (C.) mappingae*, by its more tapering shape, flatter whorls, not shouldered below the suture, and fewer ribs with relatively narrow interspaces on each whorl. The aperture also differs principally in the orientation of the columella.

Material—Holotype and one paratype, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore, Adelaide.

Turbonilla (Chemnitzia) subfusca Ludbrook

Turbonilla subfusca Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 93, pl. 5, fig. 7.

Diagnosis—A very small *Chemnitzia* with a protoconch of 2 globose helicoid turns set at right angles to the rest of the shell and partly immersed. Seven adult whorls in a height of 5.1 mm. First two adult whorls convex and without sculpture, except for inconspicuous axial striae, third whorl with axial costae developing, 14 in number, 16 on the penultimate whorl, somewhat oblique and equal to the interspaces. Aperture subquadrate, outer lip and columella vertical.

Dimensions—Height 5.1, diameter 1.0 mm.

Type Locality—Abattoirs Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 166S.

Observations—No further examples of this species have been found since it was described from Abattoirs Bore. It is readily distinguishable by the smooth and convex large whorls, together with the protoconch, if it is preserved, of 2 separately globose helicoid turns laterally situated at right angles to the rest of the shell.

Material—Two paratypes, Abattoirs Bore; one specimen, Hindmarsh Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Turbonilla (Chemnitzia) adalaidensis sp. nov.

pl. 3, fig. 13.

Diagnosis—An elongate *Chemnitzia*, slowly tapering, with 13 adult whorls and protoconch in a height of 10.5 mm. Adult whorls slightly convex, particularly in first 6 whorls, sculptured with numerous slightly oblique axial costae, rounded and about equal to interspaces, 17 on the first 2 whorls, 14 on whorls 3-8, 15 on the 9th whorl, 17 on the 10th and 11th, and 20 on the penultimate whorl.

Description of Holotype—Shell fairly large, moderately thick, elongate-subulate, slowly tapering. Protoconch prominently heterostrophic of 2 globose helicoid turns tilted at about 60 degrees to the axis. Nucleus projecting with suture of first whorl tangential to it. Adult whorls 13, slightly convex, more so in the first 6 whorls; sculptured with numerous slightly oblique axial costae, rounded and about equal to the interspaces, extending from suture to suture on the spire whorls and terminated at the periphery of the body whorl. There are 17 costae on the first 2 whorls, 14 on whorls 3-8, 15 on the 9th whorl, 17 on the 10th and 11th and 20 on the penultimate. Interspaces abruptly terminated just above the sutures and on the periphery on the body whorl, suture linear, impressed. Base smooth, moderately convex, aperture subquadrate, columella and outer lip parallel and vertical; outer lip slightly broken in the holotype.

Dimensions—Height 10.5, diameter 2, height of body whorl 2.1 mm.

Type Locality—Weymouth's Bore, 310-330 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15170.

Observations—This is an elegant and elongate *Chemnitzia* somewhat resembling *T. (C.) subfusca*. It is readily separable by its greater length and sculptured early whorls and greater number of costae.

Material—Holotype, Weymouth's Bore; one paratype (incomplete), Hindmarsh Bore; 3 paratypes, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

Turbonilla (Chemnitzia) currongae sp. nov.

pl. 3, fig. 16.

Diagnosis—A very small *Chemnitzia* with protoconch and 7 adult whorls in a height of 3.75 mm. Protoconch high at about 75 degrees to the axis with nucleus lateral, globose and partly immersed. Adult whorls shouldered at the summit with strong oblique axial ribs narrower than interspaces, increasing from 12 on the first to 20 on the penultimate whorl.

Description of Holotype—Shell very small elongate, conical. Protoconch heterostrophic, high and fairly large, of 2 helicoid turns set at about 75 degrees to the axis; nucleus prominent, lateral and slightly immersed. Protoconch followed by one-half turn with brephic axials. Adult whorls 7 fairly rapidly increasing, shouldered at the summit and flat, sculptured with strong, sharply defined axial costae slightly narrower than the interspaces, which are flat and obliquely set across the whorls at an angle of 60 degrees; there are 12 on the first, 14 on the second, 16 on the third, 18 on the fourth and fifth, and 20 on the penultimate and body whorls. Interspaces extend from suture to suture on the spire whorls, but are abruptly terminated on the periphery of the body whorl. Base smooth, convex, steeply inclined. Aperture subquadrate, slightly effuse anteriorly; columella almost vertical, outer lip slightly oblique.

Dimensions—Height 3.75, diameter 1.2, height of body whorl 1.2 mm.

Type Locality—Hindmarsh Bore, 450-487 feet.

Location of Holotype—Tate Mus. Coll., F 15171.

Observations—The number of costae, set noticeably obliquely, and the shouldering of the whorls separate this species from other species of *Chemnitzia* herein described.

Material—Holotype and one fragment of paratype, Hindmarsh Bore; one paratype, Abattoirs Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh and Abattoirs Bores, Adelaide.

Turbonilla (Chemnitzia) wideningae sp. nov.

pl. 3, figs. 14, 15.

Diagnosis—A *Chemnitzia* of moderate size, with moderately convex whorls sculptured with 16 axial ribs per whorl. Interspaces subrectangular, not terminated above the suture, but terminated on the periphery of the body whorl. Base oblique and flatly convex. Aperture subquadrate, columella slightly oblique to the left, outer lip not parallel to columella, vertical.

Description of Holotype—Shell of moderate size, elongate-tapering, solid, fairly thick. Protoconch and early whorls missing, 7 adult whorls remaining, moderately convex, sculptured with flatly rounded axial ribs, slightly wider than interspaces, oblique to gently curved, 16 per whorl, 18 on the body whorl. Interspaces subrectangular extending from suture to suture in the spire whorls and terminated abruptly on the periphery of the body whorl. Base short, smooth, oblique and flatly convex. Aperture small, base of columella and outer lip broken.

Dimensions—Height 5.6 (estimated total height 9), diameter 1.5, height of body whorl 1.8 mm.

Paratype—Portion of shell with body whorl and aperture complete. Aperture subquadrate; columella oblique to the left; outer lip vertical, lip slightly effuse anteriorly.

Type Locality—Hindmarsh Bore, 450-487 feet.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, F 15172.

Observations—This species is close to *T. (C.) wurongae* from which it differs in the number of costae per whorl and the shape of the interspaces. In *wurongae* the interspaces are elongate-triangular, with the apex of the triangle below the suture; in *wideningae* they are rectangular and not terminated above the suture.

Material—The holotype and 2 paratypes.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Hindmarsh Bore, Adelaide.

Turbonilla (Chemnitzia) sp.

It is impossible fully to describe this small *Chemnitzia* from Hindmarsh Bore of which only the three last whorls remain. The whorls are flatly convex and finely sculptured with 22 axial costae per whorl. The costae are oblique, extend from suture to suture and are separated by narrower interspaces. The interspaces are continuous from suture to suture, but are abruptly terminated at the periphery of the body whorl. The aperture is broken but appears to be subquadrate, the columella vertical. The base is smooth, flatly oblique.

The subgenus *Chemnitzia* has been recorded and the species described above for the first time from the Australian Tertiary. All of the species of which the protoconch is preserved fall into "Group A" of Laws (1937a, p. 407; 1937b, p. 49) in which the protoconch is helicoid and the intercostal grooves abruptly terminated at the periphery. *Chemnitzia* "Group A", with 2 doubtful exceptions, does not appear in New Zealand before the Nukumaruan, although *Chemnitzia* including "Group B" characterised by a planorboid protoconch appeared as early as the Hutchinsonian. It is impossible to state at this stage whether *Chemnitzia* is represented in the Australian Tertiary before the Pliocene; so far as can be

determined from figures of poorly preserved specimens described under *Turbonilla*, it is not represented.

Subgenus PYRGOLAMPROS Sacco, 1892.

Pyrgolampros Sacco, 1892, Moll. Terr. Terz. Piem. 11, p. 65.

(*Pyrgolampros* Cossmann, 1921 (emend. pro. *Pyrgolampros* Sacco) Ess. Paleo. Camp., 12, p. 287.)

Type species (u.d.) *Pyrgolampros mloperplicatulus* Sacco.

***Turbonilla* (*Pyrgolampros*) *vixcostata* Ludbrook**

Turbonilla vixcostata Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 92, pl. 5, fig. 6.

Diagnosis—A *Pyrgolampros* fairly large, solid but thin, 12 adult whorls in a height of 13 mm. sculptured with about 14 axial costae per whorl on the early whorls. Costae become weaker and gradually obsolete after the sixth whorl and disappear altogether. Aperture elongate quadrate, columella slightly plicate; aperture somewhat effuse anteriorly.

Dimensions—Height 9.8; diameter 2.2 mm.

Type Locality—Abattoirs Bore, Adelaide.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1659.

Observations—The holotype is a young shell, a typical if incomplete example reaches a height of 13 mm., diameter 3.5 mm. The species is numerous and common, and is readily distinguished by the absence of sculpture except for growth lines in the later whorls.

Material—About 55 paratypes, mostly broken, Abattoirs Bore; 10 specimens, Hindmarsh Bore; 3 specimens, Weymouth's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Adelaide District.

***Turbonilla* (? *Pyrgolampros*) sp.**

? *Turbonilla* sp. Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 93.

Observations—No further examples of this species have been recovered, and the precise location is still indeterminable.

Subgenus PYRGISCUS Philippi, 1841.

Pyrgiscus Philippi, 1841, Arch. Naturgesch., 7 (1), p. 50.

(*Pyrgostelis* Monterosato, 1884, Nom. Gen. Spec., p. 89.)

(*Ortostelis* Aradas and Maggiore, 1843, Atti. Acad. Giov. Catania, 20, p. 118.)

Type species (s.d. Dall & Bartsch, 1909) *Melania rufa* Philippi.

***Turbonilla* (*Pyrgiscus*) "*liracostata*" Tenison Woods**

Turbonilla liracostata Tenison Woods, 1877, Proc. Roy. Soc. Tas., 1876, p. 101.

Turbonilla liracostata T. Woods, Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 116.

Turbonilla liracostata T. W. Chapman, Crespin & Koble, 1928, Rec. Geol. Surv. Vic., 5 (1), p. 160.

Turbonilla liracostata T. Woods, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A small *Pyrgiscus* with 8 adult whorls and a small protoconch in a height of 5.5 mm. Whorls flattened with 20-24 straight rounded ribs; intercostal spaces narrower than ribs and closely spirally grooved. Base roundly convex and spirally lirate.

Dimensions—Length 5.5, diameter 1.5 mm.

Type Locality—Table Cape, Tasmania; "Janjukian".

Location of Holotype—? Hobart Museum, Tasmania.

Observations—The identification of this species is based on the description only. Present study is limited to one juvenile with 5 adult whorls which must be regarded as doubtfully *liracostata*. The species has previously been recorded from the Kalimnan of the Sorrento Bore (Chapman, Crespin & Koble, 1928, p. 160), but all identifications of this species in Victoria and South Australia need further study and comparison with the type for confirmation.

Material—One juvenile specimen, Hindmarsh Bore.

Stratigraphical Range—"Tertiary".

Geographical Distribution—Port Phillip Bay, Victoria, to Adelaide, S. Aust.; Tasmania.

***Turbonilla (Pyrgiscus) radicans* Chapman & Crespin**

Turbonilla radicans Chapman & Crespin, 1928, Rec. Geol. Surv. Vic., 5 (1), p. 109, pl. 7, fig. 35; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Crespin, 1943, Aust. Min. Res. Surv. Bull. 9, p. 99.

Diagnosis—A very small *Pyrgiscus* with six flattened adult whorls and a small protoconch of 2 turns in a height of 3.7 mm. Sculpture of 14 axial costae per whorl, with intercostal spaces narrower than ribs, transversely striated, the striae passing over the ribs.

Dimensions—Height 3.7, diameter 1.16 mm.

Type Locality—Sorrento Bore, Victoria, 670 ft., Kalimnan.

Location of Holotype—Geol. Surv. Vic. Coll.

Material—One example, worn, Tennant's Bore; one worn example, Weymouth's Bore.

Stratigraphical Range—"Tertiary".

Geographical Distribution—Gippsland, Vic.-Adelaide, S. Aust.

***Turbonilla* (s.l.) spp.**

Two fragments each consisting of the body and portion of the penultimate whorl were obtained from Hindmarsh Bore. It is possible that they belong to the subgenus *Pyrgiscilla* (Laws, 1937c, p. 172). The intercostal grooves are stopped at the periphery as in *Chenmitzia* and there is a suggestion of spiral striations on the intercostal spaces. However, sufficient material is not available for confirmation. The two fragments differ in the number of costae, and are not conspecific.

Superfamily HIPPONICACEA.

Family HIPPONICIDAE.

Genus CHEILEA Modest, 1793.

Cheilea Modest, 1793, K. Vetens. Acad. Handl., 14, p. 112.

(*Mitularia* Schumacher, 1817, Res. Vers. test., pp. 56, 183.)

(*Lithedaphus* Owen, 1842, Proc. Zool. Soc., p. 147.)

(*Calyptra* H. & A. Adams, 1854, Gen. Rec. Moll., 1, p. 304.)

Type species (s.d. Woodring, 1928) *Patella equestris* Linné.

***Cheilea adelaidensis* Ludbrook**

Cheilea adelaidensis Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 94, pl. 5, figs. 8, 9; 1941, *ibid.*, p. 100.

Diagnosis—Apex anterior, sharply curved in two turbinate whorls; shell smooth in the neighbourhood of the apex, central portion forming a cap with steep sides, rest of shell flattened and irregular. Sculpture from edge of smooth portion surrounding apex to adult area of numerous, very fine, waving, radial lirae wider than interspaces broken by irregular concentric lines of growth and crossed irregularly by diagonal radial grooves.

Dimensions (of cap)—Height 4, diameter 6 mm.

Paratype—The internal appendage of the paratype is semi-circular in basal outline, convex in front, fairly wide and showing irregular growth lines.

Observations—No further examples of this species have been obtained since it was described from Abattoirs Bore. The genus is widespread in warmer waters. The species was inadvertently listed as *C. pliocenica* (Ludbrook, 1941, p. 100), *pliocenica* being a nomen nudum. The species was described (p. 94) under the name *adelaidensis*.

Material—Holotype T 1666, and paratype T 1667.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Abattoirs Bore, Adelaide.

Genus *HIPPONIX* DeFrance, 1819.

Hipponix DeFrance, 1819, Bull. Sci. Soc. Philom. Paris, Jan., p. 8.

(*Hipponix* Crosse, 1862, Journ. de Conch., 10, p. 17.)

(*Cochiolepas* H. & A. Adams, 1854, Gen. Rec. Moll., 1, p. 373.)

Type species (s.d. Gray, 1847) *Patella cornucopia* Lamarck.

Subgenus *SABIA* Gray, 1847.

Sabia Gray, 1847, Proc. Zool. Soc., p. 157.

(*Amalthea* Schumacher, 1817, Ess. Vers. test., pp. 56, 181, non Rafinesque, 1815.)

(*Sabina* Zittel, 1882 (err. pro *Sabia* Gray) Handb. Pal., 2, p. 216.)

(*Capulonix* Iredale, 1929a, Mem. Qld. Mus., 9, p. 277.)

(*Saptadanta* Prasad & Rao, 1934, Rec. Ind. Mus., 36, p. 1.)

Hipponix (*Sabia*) *conicus* (Schumacher)

pl. 4, figs. 1-4.

Amalthea conica Schumacher, 1817, Ess. Vers. test., p. 181, pl. 21, fig. 4.

Patella australis Lamarck, 1819, Hist. Nat. Anim. s. Vert., 6 (1), p. 335; Delessert, 1841, Rev. Coq., pl. 23, fig. 11.

Hipponix australis Lamarck, Quoy and Gaimard, 1835, Voy. Astrolabe Zool., 3, p. 434, pl. 72, figs. 25-34; Crosse, 1862, Journ. de Conch., p. 21; Tate, Trans. Roy. Soc. S. Aust., 17, p. 330; Dornant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), pp. 138, 144.

Hipponix conicus Schumacher, Crosse, *ibid.*, p. 24; Godfrey, 1931a, S. Aust. Nat., 12 (2), p. 31, pl., fig. 12.

Amalthea conica probably = *Amalthea australis* Quoy, Angas, 1865b, Proc. Zool. Soc., p. 175.

Sabia conica Schumacher, Cotton & Godfrey, 1938, Mal. Soc. S. Aust., 1, p. 18; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A *Sabia* of variable shape, generally high, shell thick, apex posterior and directed posteriorly, smooth, sharp and incurved at tip. Sculpture of irregular radial ribs with narrow interspaces.

Description of Holotype—Shell small, rather elevated, conical, convex; apex high, smooth, posterior, directed backwards over the margin, eroded in the holotype. Exterior surface coarsely sculptured with irregular, wide, flat radial ribs, with narrow sublinear interspaces, bifurcating towards the apertural border. Aperture subcircular in the holotype; interior smooth with a long, horseshoe-shaped posterior muscular impression near the margin.

Dimensions—Height 10, antero-posterior diameter 12, lateral diameter 12 mm.

Type Locality (here designated)—Tasmania; Recent.

Location of Holotype—Zoologiske Museum, Copenhagen, Schumacher, 181, No. 1071.

Observations—The synonymy of this species and that of the species recorded as *Capulus australis* are confused in Australian literature. There appears to be failure to recognise that the species redescribed by Quoy and Gaimard was Lamarck's *Patella australis*, figured by Delessert. Lamarck's original description was republished together with Quoy and Gaimard's more detailed description of the "Astrolabe" hypotypes. Godfrey (1931a, p. 31) has synonymized *Hipponix australis* Quoy & Gaimard (*sic*) with *Amalthea conica* Schumacher, and later (1931b, p. 44) has used *Capulus australis* Lamarck for the species of *Capulus* previously known in South Australia as *Capulus daniell* Crosse. This shell is not Lamarck's *Patella australis*. It is a thin, somewhat irregular shell with a recurved apex, and has very weak and fine radial sculpture visible in oblique light in contrast with Lamarck's species of which the radial ribbing is clearly shown in Delessert's figure. Angas (1865, p. 175) considered it identical with *Capulus daniell* Crosse; one example only and four topotypes of *C. daniell* are available in the British Museum Collection so that exact comparison is difficult, but there is close resemblance between the two. Unless morphological differences are established, the Recent species recorded in South Australia as *Capulus australis* should be identified with *Capulus daniell*.

The fossil *Hipponix* (*Sabia*) *conica* is small, like the holotype which the

writer has been privileged to see by the courtesy of the Zoologiske Museum, København. The species is very variable in form and sculpture of the shell.

The holotype of *Patella australis* cannot be located (Mermod, 1950, p. 700), but is considered by Mermod to be probably a *Sabia*.

Capulonix Iredale has been included above in the synonymy of *Sabia*. This name was introduced by Iredale for the Queensland shell listed by Hedley as *Capulus calyptra* Martyn. No specimens of the Queensland shell are available for present study, but Martyn's figure appears to be that of a *Sabia*. The specific determination of the Queensland species may be erroneous, as Martyn's figured specimen (Martyn, 1784, 1, pl. 18) was recorded by the author as from the north-west coast of America.

Material—The holotype: figured hypotype (worn), Hindmarsh Bore; numerous specimens, Recent, South Australia. B.M. Coll.

Stratigraphical Range—Dry Creek Sands—Recent.

Geographical Distribution—Southern Australia.

Superfamily CALYPTRAEACEA.

Family TRICHOTROPIDAE.

Subfamily TRICHOTROPINAE.

Genus CERITHIODERMA Conrad, 1860.

Cerithioderma Conrad, 1860, Journ. Acad. Nat. Sci. Philad., ser. 2, 4, p. 295.

(*Mesostoma* Deshayes, 1864, Descri. Anim. s. Vert. Bass. Paris, Supp. 2, p. 416 (non Dujardin, 1930).)

Type species (monotypy) *Cerithioderma prima* Conrad.

Cerithioderma accrescens (Tate)

Trichotropis accrescens Tate, 1890b, Trans. Roy. Soc. S. Aust., 13 (2), p. 189, pl. 12, fig. 11; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 111; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A fairly large *Cerithioderma* with seven whorls in a height of 11.5 mm. Whorls rapidly increasing, body whorl large. Sculpture of five equal and equidistant elevated spiral lirae, with a sixth at the anterior suture, crossed by strong high axial lirae, approximately equal to the interspaces, ten in one mm. on the penultimate whorl. Base with 10 raised sharp lirae crossed by axial arcuate striae.

Dimensions—Height 11.5, diameter 5.5, height of aperture 4.5 mm.

Type Locality—Muddy Creek, Hamilton, Victoria; Miocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 763A.

Observations—No further examples of this species have been found since it was recovered from Abattoirs Bore. The species is an undoubted *Cerithioderma*; Tate (1890b, p. 185) recognized its affinities with Deshayes's *Mesostoma*, which he considered a synonym of *Trichotropis*. *Cerithioderma*, with which Deshayes's *Mesostoma* is synonymous, is well represented in the European Eocene, and *C. accrescens* is very like *C. reticulatum* Wrigley from the Bracklesham Beds. The genus is distributed in the Upper Cretaceous to Oligocene of Europe and North America, and appears to have lingered on in Australia through Miocene and Pliocene times.

Material—Holotype.

Stratigraphical Range—Miocene—Dry Creek Sands.

Geographical Distribution—Muddy Creek, Victoria—Adelaide, S. Aust.

Family CAPULIDAE

Subfamily CAPULINAE.

Genus CAPULUS Montfort, 1810.

Capulus Montfort, 1810, Conch. Syst., 2, p. 54.

(*Pileopsis* Lamarck, 1822, Hist. Nat. Anim. s. Vert., 6 (2), p. 16.)

Type species (monotypy) *Patella hungarica* Linné.

Subgenus CAPULUS s. str.

Capulus (Capulus) circinatus Tate (?)

pl. 4, figs. 5, 6.

Capulus circinatus Tate, 1893b, Trans. Roy. Soc. S. Aust., 17, p. 334, pl. 7, fig. 8; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 113; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A small, high *Capulus* with a spirally recurved apex overhanging the posterior border of the aperture. Aperture roundly ovate, sides slightly compressed. Sculpture of fine radial threads crossed by concentric folds and threads which are arched anteriorly.

Dimensions—Height 3.25, greatest diameter 2.5, lesser diameter 2 mm.

Type Locality—Adelaide Bore; Eocene.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1445.

Observations—Three examples referred to this species, from Abattoirs Bore, are all worn. The species depends on the unique holotype from the Eocene of the Adelaide Bore and appears to be a true *Capulus*. The apex is not laterally curved as in *Krebsia* (with which *Tempetastus* Iredale is synonymous) and the shell is similar in shape and in the curvature of the apex to young examples of the type species, *C. hungaricus*; adult *hungaricus* is more circular in shape, and the apex is less strongly curved in the later stages. *Capulus danieli* Crosse is also a *Capulus* s. str. Australian fossil species recorded under this name need re-examining with a view to establishing their exact identity.

Material—3 specimens, including figured hypotype, Abattoirs Bore.

Stratigraphical Range—Eocene (?) Dry Creek Sands.

Geographical Distribution—Adelaide, South Australia.

Family CALYPTRAEIDAE.

Genus CALYPTRAEA, Lamarck, 1799.

Calyptraea Lamarck, 1799, Mem. Soc. Hist. Nat. Paris, p. 78.

(*Mitrula* Gray, 1821, London Med. Repos., 15, p. 232.)

(*Mitella* Leach, 1847, in Gray Ann. Mag. Nat. Hist., 20, p. 271.)

Type species (monotypy) *Patella chinensis* Linné.

Subgenus SIGAPATELLA L \ddot{e} sson, 1830.

Sigapatella Lesson, 1830, Voy. Coquille. Zool., 2 (1), p. 380.

(*Haliotidea* Swainson, 1840, Tr \acute{e} at. Malac., p. 354.)

(*Trochella* Gray, 1867, Proc. Zool. Soc., p. 735.)

Type species (s.d. Gray, 1847) *Calyptraea (Sigapatella) novaezelandiae* Lesson.

Calyptraea (Sigapatella) crassa Tate

pl. 4, figs. 7, 8.

Calyptraea crassa Tate, 1893b, Trans. Roy. Soc. S. Aust., 17, p. 332, pl. 7, figs. 2, 7; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 138.

Sigapatella crassa Tate, Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100; Crespin, 1943, Dept. Supp. & Ship. Min. Res. Surv. Bull. 9, p. 98.

Diagnosis—A rather stout *Sigapatella* with an elevated subcentral spire, rapidly increasing. Apex prominent, small, oblique, circinately coiled. Body whorl flatly convex; sculpture of fine, lamellose growth lines. Edge of septum concave.

Dimensions—Height 11, diameters 27 and 25 mm.

Type Locality—Gippsland Lakes, Victoria; Kalimnan.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1432A.

Observations—All material available from the bores consists of young thin shells as compared with type specimens. The species occurs in some numbers in Hindmarsh and Abattoirs Bores.

Material—The figured hypotype and 19 specimens, Hindmarsh Bore; 5 specimens, Weymouth's Bore.

Stratigraphical Range—Kallimnan-Dry Creek Sands.

Geographical Distribution—Gippsland, Victoria-Adelaide, South Australia.

Genus *Crepidula* Lamarck, 1799.

Crepidula Lamarck, 1799, Mem. Soc. Hist. Nat. Paris, p. 78.

(*Proscenula* Perry, 1811, Conch., pl. 53.)

(*Sardalinum* Schumacher, 1817, Syst. Vers. test., p. 183; non Oken, 1815.)

(*Proscenula* Ferussac, 1820, Journ. de Physique, 90, p. 285.)

(*Crypta* Gray, 1847, Proc. Zool. Soc., p. 157.)

Type species (monotypy) *Patella fornicata* Linné.

Subgenus *Zeacrypta* Finlay, 1927.

Zeacrypta Finlay, 1927, Trans. N.Z. Inst., 57, p. 393.

Type species (o.d.) *Crepidula monoxyla* Lesson.

***Crepidula* (*Zeacrypta*) *immersa* Angas**

pl. 4, figs. 9-11.

Crepidula immersa Angas, 1865a, Proc. Zool. Soc., p. 57, pl. 2, fig. 12.

Crepidula unguiformis Lamarck, Tate, 1893b, Trans. Roy. Soc. S. Aust., 17, p. 330; Doumant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), pp. 144, p. 113, 138; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Zeacrypta immersa Angas, Godfrey, 1931b, S. Aust. Nat. 12 (3), p. 43; Cotton & Godfrey, 1938, Mal. Soc. S. Aust., 1, p. 18.

Diagnosis—Shell irregular in shape but generally flatly oval, thin, large in size, apex subcentral generally immersed, small, not prominent. Septum thin with straight margin.

Dimensions—Length 27, width 18, height 5 mm.

Type Locality—Port Lincoln, S. Aust., on dead *Pinna*; Recent.

Location of Holotype—Brit. Mus. (Natural History).

Observations—The habit, shared by several species of *Crepidula*, of assuming a flat or backwardly curved shape principally when inhabiting the outer lip of other shells, has led to the assumption that *C. unguiformis* Lamarck is a cosmopolitan species. It has been thus identified throughout Australian Tertiary, and it must be admitted that it is difficult if not impossible to separate the flat forms from *unguiformis* without the supporting evidence of the convex forms, which generally grow on the external surface of dead shells and adjust their shape to the species to which they are attached.

The subgenus *Janacis* Mörch (type species *Crepidula plana* Say) is retained by Wenz (1940, p. 905) for the flat shells.

Finlay (1927, p. 393) created *Zeacrypta*, as a subgenus of *Maoricrypta*, for "the series of slipper limpets that live inside dead shells", naming *Crepidula monoxyla* as type species with the added generic diagnosis of a "brehpic stage which forms a slightly raised ellipsoidal cap (with the flatly coiled smooth embryo at one of the foci) ornamented all over with fine threads radiating from the umbo". For the first criterion, that of habit, the name *Janacis* is already available; for the second, the habit of forming a cap, seen in some specimens only, has been observed by the writer without any very close study of the genus in the species *C. fornicata* Linné, *C. aspera* Dunker, *C. unguiformis* Lamarck, *C. norrisianum* Williamson, *C. plana* Say, *C. oryx* Sowerby. It does not then appear to be subgenerically diagnostic. However, *Zeacrypta* is separable from *Janacis* by the fact that the septum has a straight or but slightly curved margin while in *Janacis* there is usually a definite notch on the left side.

Adelaide specimens include both the convex and flat forms, each of which is figured (pl. 4, figs. 9-11). The species attains a large size, one broken specimen from Windmarsh Bore having an estimated total length of 55 mm., width 40 mm.

Material—Nine specimens including the figured hypotypes, Hindmarsh Bore, two specimens, Kooyonga Bore; one specimen, Tennant's Bore.

Stratigraphical Range—Dry Creek Sands.

Geographical Distribution—Southern Australia.

***Crepidula (Zeacrypta) dubitabilis* Tate**

pl. 4, fig. 12.

Crepidula dubitabilis Tate, 1893b, Trans. Roy. Soc. S. Aust., pl. 9, fig. 5; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 113, 138; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A small *Crepidula*, thin elongate-oval in shape, generally convex. Apex spiral, submarginal.

Dimensions—Length 25, width 16, height 8 mm.

Type Locality—Gippsland Lakes, Victoria; Kalinman.

Location of Holotype—Tate Mus. Coll., Univ. of Adelaide, T 1424.

Description of Hypotype—Shell rather small, thin elongate-oval in shape, sides contracted, irregularly sculptured with concentric growth lines and irregular curved radial ridges which, however, are not present on other specimens. Apex pronouncedly spiral, subcentral, small separated from the margin, and curved to the left. Septum small, deeply set, margin broken in hypotype but otherwise slightly concavely curved.

Dimensions—Length 18, width 9, height 6 mm.

Locality—Abattoirs Bore.

Location of Hypotype—Tate Mus. Coll., Univ. of Adelaide, F 15173.

Observations—Three specimens are available from Adelaide material and all show the conspicuously spiral apex which is set in from the margin slightly to the left of the centre.

Material—The hypotype and one specimen, Abattoirs Bore; one specimen and three juvenile specimens, Weymouth's Bore.

Stratigraphical Range—Miocene-Dry Creek Sands.

Geographical Distribution—Gippsland, Vic.-Adelaide, South Australia.

***Crepidula (Zeacrypta) hainsworthi* Johnston**

pl. 4, figs. 13, 14.

Crepidula hainsworthi Johnston, 1885, Proc. Roy. Soc. Tas. for 1884, p. 233, pl. figs. a-c; 1888, Geol. Tas., pl. 32, fig. 13; Tate, 1893b, Trans. Roy. Soc. S. Aust., 17, p. 330; Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 113; Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 100.

Diagnosis—A narrow, high *Crepidula*, with basal outline elongate-oval. Apex strongly hooked, posterior, projecting beyond the posterior margin.

Dimensions—Length 14, breadth 8, height 5.5 mm.

Type Locality—Table Cape, Tasmania.

Location of Holotype—? Hobart Museum.

Observations—This is a very distinctive species with its high apex downwardly recurved outside the posterior margin. None of the Adelaide examples show any evidence of there being a flat form of the species, but according to the author, "The younger examples differ very much in appearance from the mature forms, being relatively shallower and scarcely beaked", from which it may be assumed that the flatter variety does occur.

Material—The figured hypotype and 6 specimens, Abattoirs Bore; five specimens and one fragment, Weymouth's Bore.

Stratigraphical Range—? Oligocene and Dry Creek Sands.

Geographical Distribution—Table Cape, Tas.; Adelaide, South Australia.

Family STRUTHIOLARIIDAE.

Genus TYLOSPIRA Harris, 1897.

Tylospira Harris, 1897, Cat. Tert. Moll. Brit. Mus., 1, p. 222.

Type species (o.d.) *Buccinum scutulatum* Martyn.

***Tylospira coronata* marwicki (Finlay)**

pl. 1, figs. 6, 7.

Pellicaria coronata Tate, 1890a, Trans. Roy. Soc. S. Aust., 13 (2), p. 176.

Tylospira coronata Tate, Dennant & Kitson, 1903, Rec. Geol. Surv. Vic., 1 (2), p. 144.

Pellicaria marwicki Finlay, 1931, Trans. N.Z. Inst., 2 (1), p. 17.

Pellicaria howchini Cotton, 1934, S. Aust. Nat., 16 (1), p. 7.

Tylospira coronata marwicki (Finlay), Ludbrook, 1941, Trans. Roy. Soc. S. Aust., 65 (1), p. 89.

Diagnosis—A *Tylospira* with a somewhat short spire, generally two-ninths of total height of shell. Spire whorls convex to subangulate at first, becoming angulate by the third whorl. Early whorls sculptured with nine spiral lirae, with a row of small peripheral nodules developing on the angle of the whorl. Apertural callus thick, spreading over body whorl and up to three-quarters of penultimate whorl.

Description of Hypotype—Shell acuminate ovate, with a moderately acute, relatively small spire. Protoconch missing, adult whorls six, moderately rapidly increasing, convex to subangulate at first, but angulate by the third whorl; body whorl large, seven-ninths total height of shell, slightly depressed between suture and shoulder. Suture widely but not deeply canaliculate. Sculpture on early whorls of about nine spiral lirae and a row of small peripheral nodules gradually developing on the angle of the whorl. Callus enamel spreading over body whorl and three-quarters of penultimate whorl. Aperture elongate-oval, angulate both posteriorly and anteriorly. Outer lip thickened but not variced, broadly V-shaped in profile, arched to the left medially. Columella smooth, concave, strongly arcuate. Growth lines on callus strong and sigmoid, following the profile of the outer lip but terminating at the pad of smooth, thicker callus spreading back from the columella.

Dimensions—Height 45, diameter 31, height of body whorl 35, height of aperture 24 mm.

Type Locality—Abattoirs Bore.

Location of Holotype—Finlay Collection, New Zealand.

Location of Hypotypes—Tate Mus. Coll., Univ. of Adelaide. F 15174.

Observations—The writer (also 1941, p. 89) considers this a geographical subspecies of the restricted Kalimnan *Tylospira coronata* (Tate). The subspecies has never been completely described or figured. Finlay (1931, p. 17) differentiated it as a separate species on differences exhibited by what was evidently an incompletely developed shell, and Cotton based his species *howchini* on an eroded shell, also rather immature, on which the sculptured features were almost unrecognizable. Figured here (pl. 1, fig. 7) is the hypotype described above, of the same size and approximate dimensions as Tate's holotype of *T. coronata* s. str. Figured also (pl. 1, fig. 6) is a younger specimen showing the features on which the Adelaide shell was separated specifically by Finlay and later by Cotton. The adult specimen is less conspicuously sulcate than *coronata* s. str. and the later spire whorls are less angulate and nodulose, but the early spire whorls are the same in both species and there is no difference in the body whorl: the growth lines and outer lip are not, as stated by Finlay, "far more sigmoid". The measurements of the adult shell are so nearly like those of the holotype that one cannot accurately describe it as "more squat".

Material—Nine specimens. Hindmarsh Bore; for comparison, 9 topotypes of *coronata* s. str., Muddy Creek, Victoria; 4 specimens, Gippsland, Victoria; B.M. Collection.

Stratigraphical Range (of species)—Kalimnan-Dry Creek Sands.

Geographical Distribution—Gippsland, Vic.-Adelaide, South Australia.

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EXPLANATION OF PLATES

PLATE 1

- Fig. 1.- *Theridium* (*Chavanicerithium*) *torri* (Tate). Hypotype, juvenile, F 15175, $\times 1.3$.
- Fig. 2.- *Theridium* (*Chavanicerithium*) *torri* (Tate). Hypotype, F 15176, Abattoirs Bore, $\times 1.3$.
- Fig. 3.- *Theridium* (*Chavanicerithium*) *adeloidensis* (Hawchin & Cotton). Hypotype, Hindmarsh Bore, 450-485 feet, F 15178, $\times 1.3$.

- Fig. 4.—*Diastoma proclis* Tate. Holotype, Dry Creek Bore, T 1541, x 2.
 Fig. 5.—*Theridium* (*Theridium*) *jallax* (Ludbrook). Hypotype, Bore Hundred of Munno Para Sec. 4251, 238-256 feet, x 1-3.
 Fig. 6.—*Tylospira coronata murwicksi* Flalay. Hypotype, immature specimen, Hindmarsh Bore, 450-185 feet, x 2/3.
 Fig. 7.—*Tylospira coronata murwicksi* Finlay. Hypotype, Hindmarsh Bore, 450-485 feet, x 2/3.

PLATE 2

- Fig. 1.—*Turritella* (*Colpospira*) *platyspiroides* sp. nov. Holotype, Abattoirs Bore, x 3.
 Fig. 2.—*Turritella* (*Colpospira*) *platyspiroides* sp. nov. Paratype, Abattoirs Bore, x 3.
 Fig. 3.—*Valsantia spectabilis* sp. nov. Holotype, Hindmarsh Bore, x 10.
 Fig. 4.—*Architectonica wannonensis* (T. Woods). Hypotype, Weymouth's Bore, apical view, x 7.
 Fig. 5.—. . . lateral view, x 7.
 Fig. 6.—*Ataxocerithium bidenticulatum* sp. nov. Holotype, Weymouth's Bore, x 4; protoconch, x 12.
 Fig. 7.—*Ataxocerithium bidenticulatum* sp. nov. Paratype a, x 4; protoconch of paratype b, x 12.
 Fig. 8.—*Bittium* (*Semibittium*) *subgranarium* sp. nov. Holotype, Hindmarsh Bore, x 10.
 Fig. 9.—*Semicerithium capillatus* Tate. Hypotype, Hindmarsh Bore, x 3.
 Fig. 10.—*Hypotrochus semiplicatus* sp. nov. Holotype, Weymouth's Bore, x 5.
 Fig. 11.—*Cerithiella* (*Coxellaria*) *trigeminata* Chapman & Crespin. Hypotype, Brown Coal Shaft, Altona, Victoria, x 6.
 Fig. 12.—*Cerithiella* (*Coxellaria*) *superspiralis* sp. nov. Holotype, Abattoirs Bore, x 5.
 Fig. 13.—*Seila* (*Notoseila*) *triplicincta* sp. nov. Holotype, Abattoirs Bore, x 3-3.
 Fig. 14.—*Seila* (*Notoseila*) *triplicincta* sp. nov. Paratype, Hindmarsh Bore, x 5.
 Fig. 15.—*Triphora* (*Isotriphora*) *salisburyensis* sp. nov. Holotype, Weymouth's Bore, x 6.
 a. Protoconch of paratype, x 40.
 Fig. 16.—*Triphora* (*Notosinister*) *praegranifera* sp. nov. Holotype, Weymouth's Bore, x 10.
 a. Protoconch x 20.

PLATE 3

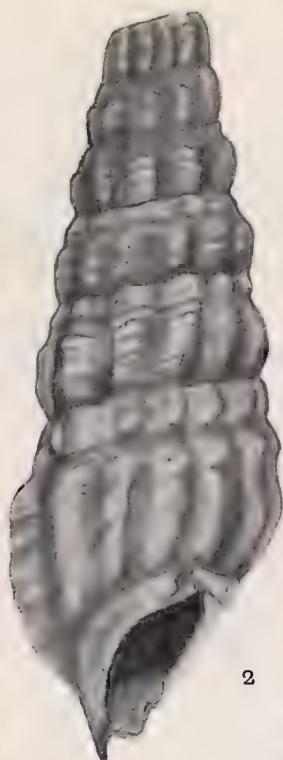
- Fig. 1.—*Amuea* (*Amuea*) *triplicata* (Tate). Hypotype, Hindmarsh Bore, x 3.
 Fig. 2.—*Leiostraca* (*Leiostraca*) *acutissimu* Sowerby. Hindmarsh Bore, x 4.
 Fig. 3.—*Niso psila*, T. Woods. Hypotype, Weymouth's Bore, x 4.
 Fig. 4.—*Syrnola lineata* Angas. Hypotype, Weymouth's Bore, x 6.
 Fig. 5.—*Syrnola* (*Agatha*) *prae fasciata* sp. nov. Holotype, Weymouth's Bore, x 6.
 Fig. 6.—*Syrnola* (*Agatha*) *jonesiana* (Tate). Hypotype, Weymouth's Bore, x 6.
 Fig. 7.—*Syrnola* (*Agatha*) *infrasulcata* (Tate). Hypotype, Weymouth's Bore, x 4.
 Fig. 8.—*Syrnola* (*Puposyrnola*) *tasmanica* T. Woods. Hypotype, Muddy Creek, x 10.
 Fig. 9.—*Syrnola* (*Evelynella*) *adelaidensis* sp. nov. Holotype, Hindmarsh Bore, x 7.
 Fig. 10.—*Turbonilla* (*Turbonilla*) *mariae* T. Woods. Hypotype, Hindmarsh Bore, x 10.
 Fig. 11.—*Turbonilla* (*Chemnitzia*) *mappingae* sp. nov. Holotype, Weymouth's Bore, x 8.
 Fig. 12.—*Turbonilla* (*Chemnitzia*) *warrongae* sp. nov. Holotype, Hindmarsh Bore, x 7.
 Fig. 13.—*Turbonilla* (*Chemnitzia*) *adelaidensis* sp. nov. Holotype, Weymouth's Bore, x 5.
 Protoconch, x 15.
 Fig. 14.—*Turbonilla* (*Chemnitzia*) *ichilingae* sp. nov. Paratype, x 6.
 Fig. 15.—*Turbonilla* (*Chemnitzia*) *ichilingae* sp. nov. Holotype, Hindmarsh Bore, x 6.
 Fig. 16.—*Turbonilla* (*Chemnitzia*) *currongae* sp. nov. Holotype, Hindmarsh Bore, x 2.
 Protoconch, x 20.

PLATE 4

- Fig. 1.—*Hipponic* (*Sabia*) *conicus* (Schumacher). Holotype, Recent. x 1-5. British Museum photo.
 Fig. 2.—. . . x 1-5. British Museum photo.
 Fig. 3.—*Hipponic* (*Sabia*) *conicus* (Schumacher). Hypotype, Hindmarsh Bore, x 4.
 Fig. 4.—. . . x 4.
 Fig. 5.—*Capulus circinalis* Tate. Hypotype, Abattoirs Bore, x 4.
 Fig. 6.—. . . x 4.
 Fig. 7.—*Calyptraca* (*Sigapatella*) *crassa* Tate. Hypotype, Hindmarsh Bore, x 3.
 Fig. 8.—. . . x 3.
 Fig. 9.—*Crepidula* (*Zeacrypta*) *immersa* Angas. Hypotype, convex variety, Hindmarsh Bore, x 1.
 Fig. 10.—*Crepidula* (*Zeacrypta*) *immersa* Angas. Hypotype, flat, curved variety, Hindmarsh Bore, x 1.
 Fig. 11.—. . . x 1.
 Fig. 12.—*Crepidula dubitabilis* Tate. Hypotype, Abattoirs Bore, x 1-5.
 Fig. 13.—*Crepidula* (*Zeacrypta*) *hainsworthi* Johnston. Hypotype, Abattoirs Bore, x 1-3.
 Fig. 14.—. . . x 1-3.



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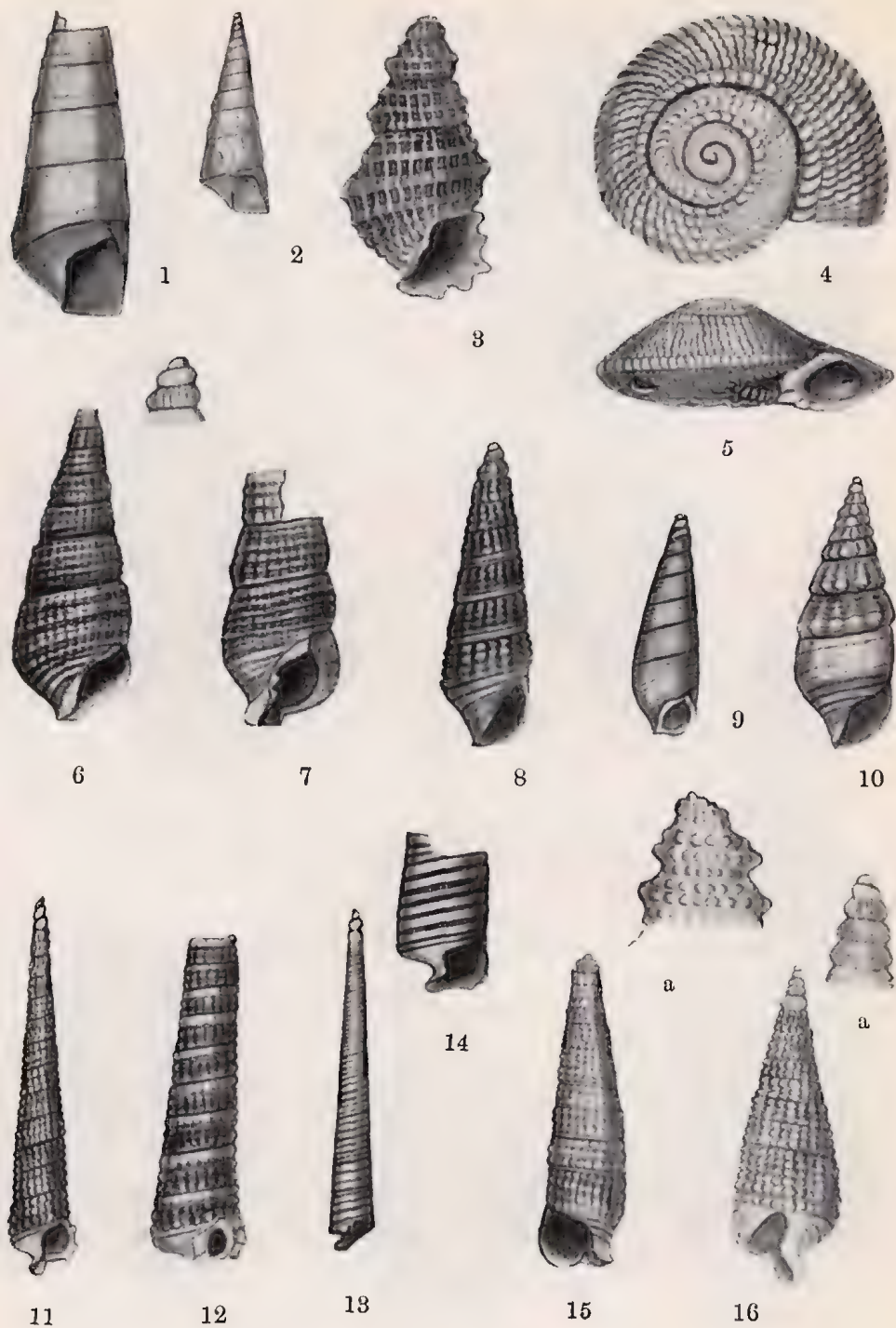
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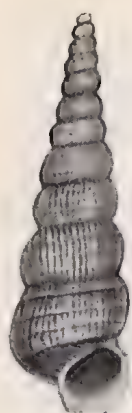


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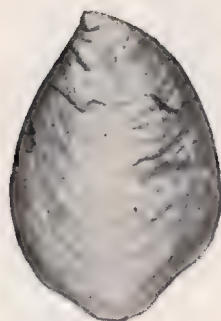
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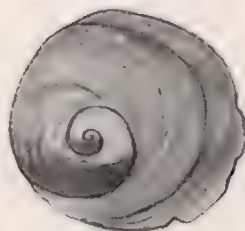
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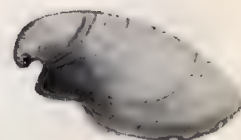
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STRATIGRAPHIC SUCCESSION EAST OF GREY SPUR, SOUTH AUSTRALIA

BY B. G. FORBES

Summary

Between Grey Spur and Port Elliot, South Australia, is a faulted and folded sedimentary sequence with a possible stratigraphic thickness of 29,000 feet. The succession overlies an Archaean inlier along an unconformity partly obscured by dynamic metamorphism.

In the main area investigated the succession dips steeply in a direction about 130 degrees east of north. Four subdivisions are distinguished. The oldest subdivision most resembles the Adelaide System. It is in part folded and appears to be separated from overlying slate and metamorphosed subgreywacke by a structural break. Conformably overlying the subgreywacke is a thick sequence, chiefly meta-arkose. The youngest subdivision is composed of metagreywacke and slate and may be correlated lithologically with the Kanmantoo Group.

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by B. G. FORBES *

[Read 10 May, 1956]

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INTRODUCTION

Rocks of Proterozoic age in South Australia have been extensively investigated on the western scarp of the Mount Lofty Ranges and in the Flinders Ranges. Knowledge of the sedimentary succession to the east of the Archaean inliers is not as advanced; this paper is presented as a contribution to that knowledge.

The area investigated occurs mainly on the Milang Sheet and partly on the Encounter Bay and Yankalilla Sheets (1:63,360 military survey). Spring Mount, the centre of field operations, is about 38 miles almost due south of Adelaide. The area extends from a little west of Spring Mount to about two miles north-west of Port Elliot.

The region has been investigated previously by a number of workers, including Howchin, King, Guppy, Sir Douglas Mawson and more recently by Campana and Wilson. Campana and Wilson's paper of 1955 may well be referred to for an account of regional topography, including glacial phenomena.

Field and laboratory study was made in 1952 during the tenure of a Junior Research Scholarship at the University of Adelaide. I am indebted to Sir Douglas Mawson for suggesting the problem and for help during the year's work.

Acknowledgment is due also to senior students and members of the Geology Department staff for assistance and advice.

STRUCTURAL GEOLOGY

Structural geology of Fleurieu Peninsula may be found very broadly summarized in Campana's paper on the Mt. Lofty-Olary Arc (Campana, 1955; in particular Plate 2, section 2-2).

The area described here extends eastward from the eastern margin of the Myponga Archaean inlier. This inlier is broadly anticlinal and overturned to the west. Successively further east of the inlier are the following groups of rocks:

Grey Spur beds (Proterozoic),
Strangway Hill beds,
Inman Hill formation,
Brown Hill beds.

* Department of Geology, University of Adelaide.

There is a structural break between the Grey Spur beds and the succeeding three groups, which are conformable.

The groups in their structural aspects are discussed in order below: see also the map and Figure 1.

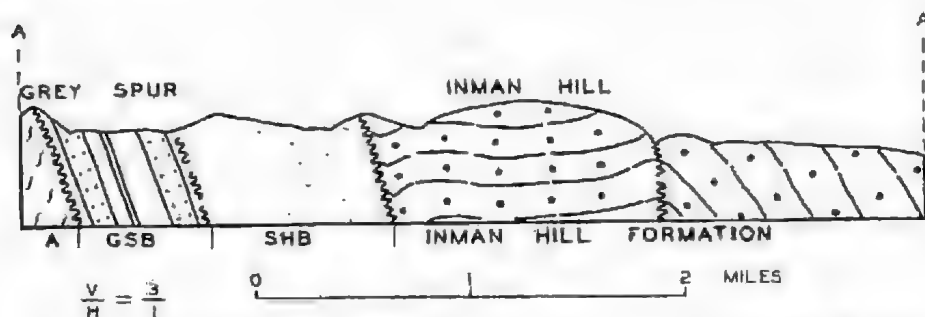


Fig. 1.—Sketch section AA. Abbreviations are as follows: A, Archaean; GSB, Grey Spur beds; SHB, Strangway Hill beds.

ARCHAEAN—PROTEROZOIC BOUNDARY

Both the western (near Myponga Hill) and eastern margins of the Archaean inlier are zones of differential movement. This is inferred from the fact that both the marginal conglomerate and the Archaean gneiss have been dynamically metamorphosed to produce augen gneisses and schists of similar appearance (metamorphic convergence).

Outcrops near Myponga Hill are poor in the zone of movement but the sequence of (1) unmodified Proterozoic slates and quartzites, (2) augen gneiss (modified conglomerate) and schists, (3) unmodified Archaean pegmatite, gneiss and calc-silicate hornfels may be traced. The slates dip beneath the Archaean gneisses approximately parallel to the schistosity conferred by the movement. The schistosity has the attitude: strike 50 degrees east of north, dip 50 degrees south.

Grey Spur provides the best exposures of the eastern margin. In the upper coarse arkose phase, of the conglomerate, quartz and feldspar phenoclasts are extended most in the bedding-plane parallel to the dip-trace. The intensity of dynamic metamorphism, as indicated by elongation of cobbles within the conglomerate, increases as the Archaean contact is neared. The pink granitic gneiss (A57.57) occurs about forty feet from recognizable strongly sheared conglomerate in which some cobbles have dimensions $1\frac{1}{2} \times 20$ inches, 1×15 inches. Between "stretched" conglomerate and Archaean gneiss is a sericitic gritty schist.

GREY SPUR BEDS, STRANGWAY HILL BEDS, INMAN HILL FORMATION

A central member of the Grey Spur beds has been tightly folded and from a first glance at the accompanying map it would appear that the whole succession is a syncline pitching at a shallow angle to the north. If this is so there must exist between the Grey Spur beds and the Inman Hill formation a major break, since the top of the Strangway-Inman Hill succession lies to the south-east.

An alternative and not so spectacular interpretation is that the tightly folded quartzite marks the anticlinal portion of a large drag-fold pitching south-west, paralleled by a synclinal axis a short distance west. Reasons for this are:—

- (1) There is no symmetry about the axis of folding;

- (2) About one mile north-north-east of Spring Mount the Grey Spur beds appear to be younger to the east, as indicated by cross-bedding.
- (3) A small (drag?) fold about half a mile north-west of Spring Mount simulates this mode of folding.

There is a disturbed zone in the Grey Spur beds about one mile south-west of Spring Mount, but paucity of outcrops renders interpretation difficult. The thin flexed quartzite and the clongate hill of quartzite may be a reflection of the folding revealed more clearly further south-west in the Inman Hill formation.

BROWN HILL BEDS

Within the metagreywacke-slate succession there is a marked cleavage trending about 45 degrees east of north and dipping at a steep angle. The average strike and dip of bedding planes, which are rarely seen in a single outcrop, are 35 degrees east of north and 70 degrees east, respectively.

Undoubted anticlinal folding occurs west of Brown Hill with pitch (about 30 degrees?) to the north-west.

PETROLOGY AND STRATIGRAPHY

ARCHAEOAN COMPLEX

Gneisses and schists of Archaean age occur west of the marginal conglomerate and have been investigated for a short distance from the conglomerate. The common rock types are gneisses of a granitic character interspersed with simple microcline-quartz pegmatites and in one locality, a calc-silicate hornfels. Where the mineral association is diagnostic, the albite-epidote-amphibolite facies of metamorphism is indicated. Superimposed on this in some rocks is a more recent retrograde metamorphism of the biotite-chlorite sub-facies.

GREY SPUR BEDS

Although alternating quartzite and schist characterize this succession, conglomerate and arkose are included. The western and stratigraphically lower boundary is marked by the junction of Archaean gneisses and schists with a marginal conglomerate. The conglomerate is best known at Grey Spur, from where it stretches north-east with few breaks to Edinburgh Swamp. The thickness of individual units and that of the whole succession increases gradually toward the north. The formation more than doubles its thickness for the three miles mapped along the strike. In the centre of the part mapped the beds have a total outcrop width of about one mile, with a possible stratigraphic thickness in the neighbourhood of 3,000 feet.

The marginal conglomerate outcrops well only in a few places along its strike. The best locality for examination is on the north-east side of Grey Spur. However, it may be followed readily even where there is no outcrop, because of the distinctive rounded cobbles lying on the surface.

The upper part of the bed is an arkose (A57.56) and is probably representative of the conglomerate matrix as a whole. Feldspar constitutes 30 p.c. and occurs mainly with quartz-hornfels as phenocrasts. Both microcline and acid plagioclase are present. The matrix is recrystallized quartz with chlorite, sericite, and accessory iron ore, tourmaline, zircon and apatite. The arkose exhibits cross-bedding, indicating that the top is to the south-east.

Schists with some slates comprise nearly two-thirds of the Grey Spur beds. They are commonly fine-grained gray rocks. The schistosity planes sparkle with mica, which is mainly biotite. Besides quartz the schists contain a little feldspar and sericite with accessory tourmaline. Biotite shows a marked preferred orientation.

These beds are poorly outcropping.

Near Grey Spur is a series of alternating bands of meta-arkose, schist and fine-grained metagreywacke, arkose being predominant. The meta-arkose is massive or banded and cross-bedded, of a pale grey to white colour. It is a compact hard recrystallized fine-grained rock composed of quartz, about thirty p.c. feldspar and a little accessory sericite, tourmaline, pyrite and apatite. Associated metagreywacke is finer grained, richer in biotite and of a dark grey colour.

About half the quartzites typifying the formation are orthoquartzites (to use Pettijohn's 1949 terminology), the remainder being feldspathic quartzites. They are all compact, light-coloured recrystallized rocks, the feldspar content ranging from almost nil to about ten p.c. Grain-size is chiefly fine, but individual rounded grains of quartz and feldspar may reach a diameter of 1 mm. Tourmaline, zircon, and pyrite are occasional accessories. In the quartzites possessing a "fused" appearance recrystallization has been more intense. The quartzites, including the fused variety, show occasional cross-bedding, though generally not clearly enough to establish the facing of the beds.

One calcareous horizon was observed, and that in only one place—the bottom of a narrow deep valley about one mile north-east of Grey Spur. Here a siliceous marble grades upward into quartzite.

STRANGWAY HILL BEDS

The southernmost extension of this formation is composed of about 1,200 feet of blue-grey slate overlain by 2,800 feet of metamorphosed subgreywacke, some schist and rare beds richer in quartz. The upper limit is marked by alternating meta-arkose and metagreywacke passing conformably upward into the Inman Hill formation. This boundary may be mapped and its approximate position appears on the accompanying plan. The lower limit, save in the south, is poorly exposed.

The poorly outcropping equivalents of these beds, forming part of the range to the south of the Upper Hindmarsh Valley, are subgreywacke and spotted schists with interbedded quartzite.

The rock termed metamorphosed subgreywacke is a grey, fine-grained slightly schistose quartz-biotite rock of subgreywacke composition. The average grain diameter of 0.09 mm. is on the border of sand and silt. The massive outcrops possess a smooth, dark-grey surface. Variations due to change in grain-size or proportions of constituents give rise to interbedded quartzite, schists and spotted schists.

Interbedded quartzite is more prominent to the north, possibly indicating a slight change in facies.

INMAN HILL FORMATION

Meta-arkose predominates in this formation, but minor thicknesses of metagreywacke also occur within it. The outcrop width is just over three miles. The formation extends from the River Inman south west of Inman Hill to a line bearing about 30 degrees just east of Peeralilla Hill. Further east the characteristic rock-type is metagreywacke.

In view of a variation in dip from 25 degrees to vertical the calculated thickness is only approximate. The thickness of the formation based on an average dip of 50 degrees is 14,300 feet.

The meta-arkose is similar macroscopically to the average quartzite. The massive variety is a hard, compact light grey to light brown rock. When streaked with thin biotite-rich bands the composition is still that of an arkose but may grade into greywacke by an increase in the proportion of micas.

In thin section these rocks are seen to be largely recrystallized, perhaps with the exception of feldspar and some accessory minerals. Average grain

diameter varies from about 0.13 to 0.28 mm. The measured feldspar content, acid plagioclase and microcline, ranges from 33 to 50 per cent. by volume. Biotite and sericite show a preferred orientation. Accessories are the common iron ore, apatite, zircon and tourmaline. The composition of meta-arkose and other rocks is plotted in Figure 2.

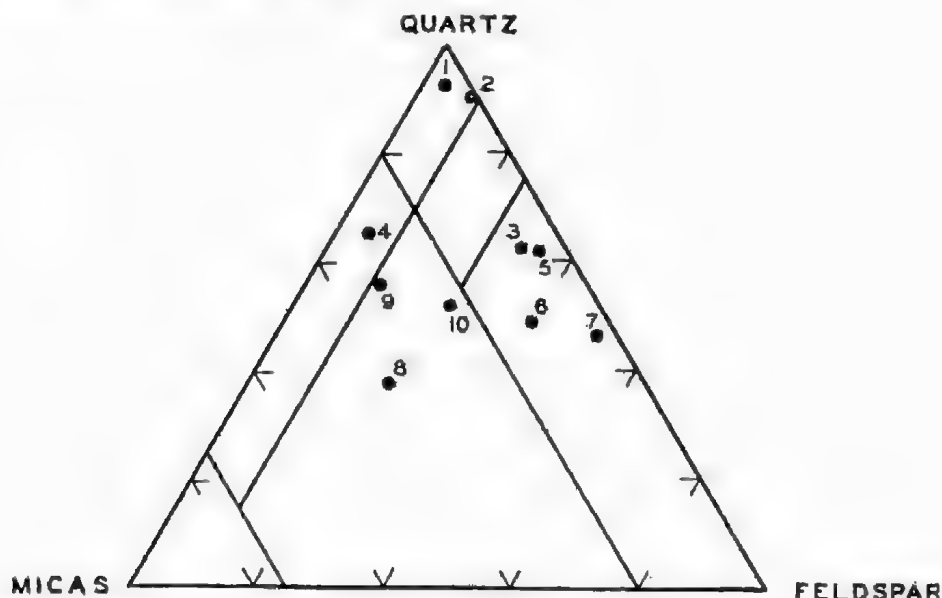


Fig. 2.—Composition of representative meta-sedimentary rocks, in terms of volume-percentage of three major constituents (measurement by microscope, using integration stage). Numbers represent specimens as follows: 1, 2—quartzite of Grey Spur beds; 3—meta-arkose of Grey Spur beds; 4—metasubgreywacke of Strangway Hill beds; 5, 6, 7—meta-arkose of Inman Hill formation; 8, 9—metagreywacke of Inman Hill formation; 10—metagreywacke of Brown Hill beds. (Subdivision of diagram after Pettijohn, 1949, p. 227.)

Banded arkoses exhibit a variety of sedimentary structures. The most useful is cross-bedding, all observations on which indicate that the top of the formation is to the east. These observations are in my opinion sufficiently widespread to indicate that there is little, if any, repetition by folding within the formation. It is possible, however, that there has been repetition by strike faulting. Slumps are another common structure. Overturned slump folds generally have an amplitude of six to twelve inches, but in one instance more than five feet was measured. The slumping has mostly taken place on surfaces sloping down to the south. Truncated slump structures are present and serve to confirm the conclusions from cross-bedding. Small scale pene-contemporaneous faulting also occurs within the formation.

BROWN HILL BEDS

Conformably overlying the Inman Hill formation are beds, predominantly metagreywacke, of about 7,000 feet thickness, overlain in turn by slates.

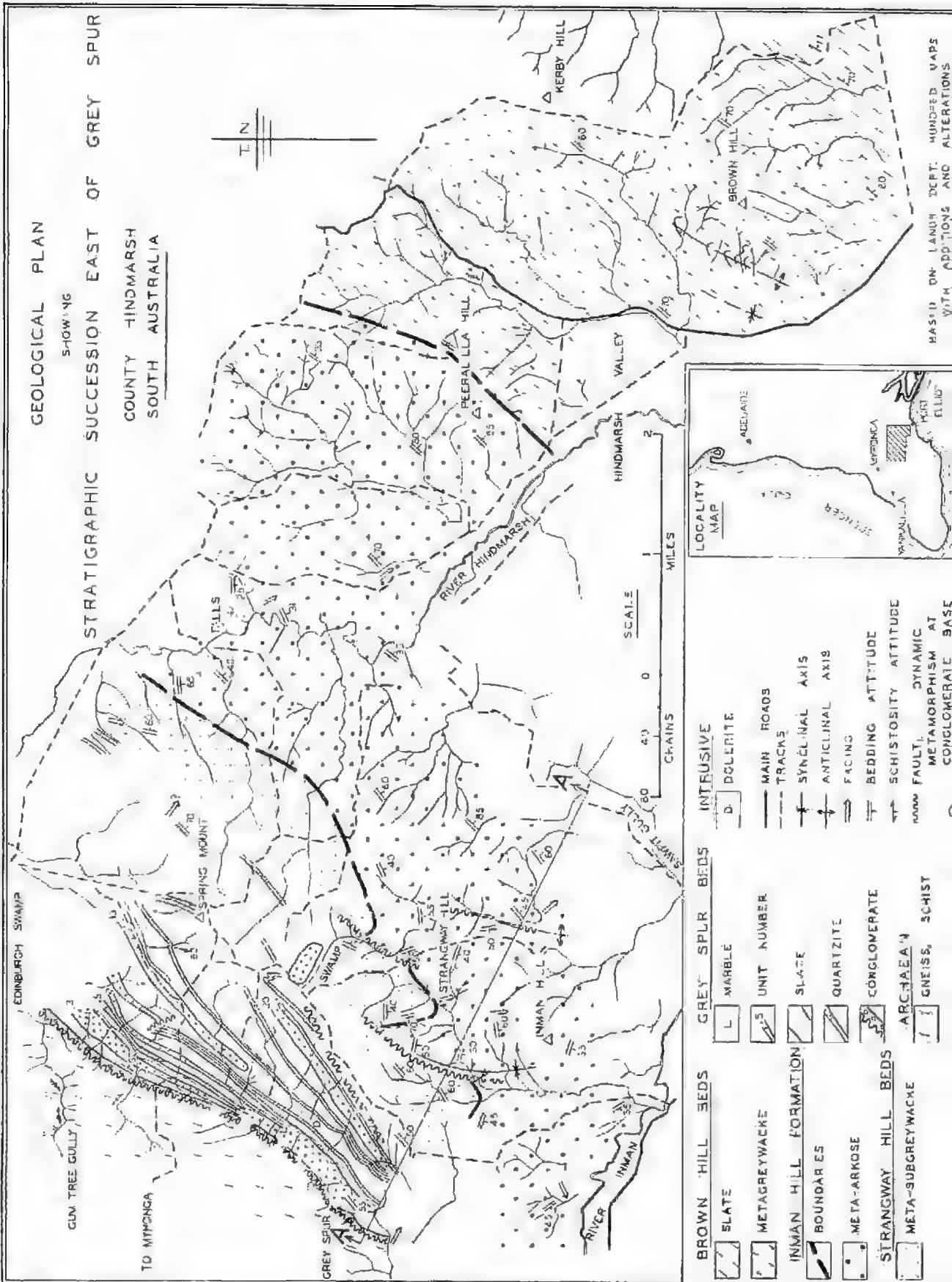
The metagreywackes vary from light to dark grey and possess a strongly developed schistosity. Granularity also varies, but is chiefly fine. Microscopically the metagreywacke A57-83 is made up of lens-shaped grains of quartz with longer axes parallel. Interstitial to quartz and feldspar are micas with a parallel orientation. Accessory minerals are epidote, zircon, tourmaline, apatite and iron ore.

GEOLOGICAL PLAN

SHOWING

STRATIGRAPHIC SUCCESSION EAST OF GREY SPUR

COUNTY HINDMARSH
SOUTH AUSTRALIA



INTRUSIVE

D. DOLERITE

GREY SPUR BEDS

L. MARBLE

BROWN HILL BEDS

SLATE

UNIT NUMBER

SLATE

QUARTZITE

CONGLOMERATE

ARCHAIC

GNEISS, SCHIST

BOUNDARIES

META-ARKOSE

STRANGWAY HILL BEDS

META-SUBGREYWACKE

ARCHAIC

GNEISS, SCHIST

MAIN ROADS

TRACKS

SYNCLINAL AXIS

ANTICLINAL AXIS

FACING

BEDDING ATTITUDE

SCHISTOSITY ATTITUDE

FAULT

DYNAMIC METAMORPHISM AT CONGLOMERATE BASE

HASID ON LAND DEPT. HUNDRED VAPS WITH ADDITIONAL ALTERATIONS

Both the interbedded and overlying slates are chiefly dark-coloured. The upper boundary of the metagreywacke beds has been indicated only tentatively on the map.

STRATIGRAPHIC INTERPRETATION

The rock-types described represent three phases of sedimentation:

- (1) Stable shelf;
- (2) Sharp uplift with corresponding slow subsidence of the basin of deposition;
- (3) Sharp uplift with corresponding rapid subsidence.

Evidence of condition (1) is supplied by the Grey Spur beds. The cobble component of the marginal conglomerate is oligomictic in character, while the arkose component is presumably a "basal" arkose. The formation represents marine transgression over the stable continental shelf accompanied by slight fluctuations in level. The source area, in view of the well-sorted nature of the deposits, possessed probably a mature or senile topography. This sequence is the one which most resembles the Adelaide system.

The Strangway Hill beds possibly represent conditions transitional between (1) and (2).

The Inman Hill formation is considered to be tectonic arkose, reflecting rapid uplift of a neighbouring granitic area. The frequent cross-bedding encountered in this formation suggests shallow-water accumulation, hence a slowly subsiding area of deposition is postulated.

The post-arkose interbedded greywackes and slates represent original muddy sandstones and dark muds deposited rapidly below wave-base. They therefore suggest geosynclinal or unstable shelf conditions (3).

The shape of the area investigated allows very little enquiry into facies change. Such time markers as tillite or fossils are not present in the sequence, hence an age cannot be assigned.

The Brown Hill beds may be correlated lithologically with the Kanmantoo Group (Sprigg and Campana, 1953). The position of the Inman Hill formation is less clear. It is perhaps a local variant within the Kanmantoo Group. Between the Grey Spur beds, lithologically similar to the Adelaide System, and the Strangway Hill beds, there is a disturbed zone where outcrops are poor. This zone may well represent the faulting-out of part of the succession.

INTRUSIVE ROCKS

Three occurrences of altered dolerite are indicated on the map. The dolerites are all unalitized and considerably altered, but show ophitic texture under the microscope.

METAMORPHISM

The post-Archaeon rocks are low grade metamorphic, the sub-facies of metamorphism being the biotite chlorite subfacies of the green-schist facies.

The general metamorphism is dynamo-thermal with, in some localities, a marked stress factor. Within the Strangway Hill beds certain spotted schists (A57-66) may represent deficient stress.

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NEW GENERA AND SPECIES OF ACARINA FROM BATS FROM NEW GUINEA, PHILIPPINES AND AUSTRALIA

BY H. WOMERSLEY

Summary

Three new species of mites belonging to two new genera of the family Laelaptidae and to the genus *Neomyobia* of the Myobiidae are described. The genus *Notolaelaps* with type *nova guinea* sp. nov. is erected for a species parasitic on a small fruit-eating bat *Syconycteris crassa papuana* Matschie 1899, from the Jimmi Valley, Western Highlands of New Guinea.

Plesiolaelaps gen. nov. is proposed for the type *miniopterus* sp. nov. from bats *Miniopterus schreibersi* (Natterer, 1819) and *Nyctophilus geoffreyi* Leach, 1821; the first from Joanna, S. Aust., 10th Dec., 1932, and the second host from Sutherlands, S. Aust., 23rd August, 1955.

Neomyobia luzonensis sp. nov. is described from many specimens of both sexes as well as nymphs, from a bat from Manila, Luzon, Philippine Islands, 25th March, 1945.

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II. WOMERSLEY*

Text Fig. 1-3.

[Read 14 June 1956]

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Three new species of mites belonging to two new genera of the family Laelaptidae and to the genus *Neomyobia* of the Myobiidae are described. The genus *Notolaelaps* with type *nova guinea* sp. nov. is erected for a species parasitic on a small fruit-eating bat *Syconycteris crassa papuana* Matschie 1899, from the Jimmi Valley, Western Highlands of New Guinea.

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Neomyobia luzonensis sp. nov. is described from many specimens of both sexes as well as nymphs, from a bat from Manila, Luzon, Philippine Islands, 25th March, 1945.

Subfamily LAELAPTINAE Berlese, 1892

Genus NOTOLAEAPS nov.

Allied to *Neolaelaps* Hirst in having only 3 pairs of genito-ventral setae in the female, but differs in the more oval shape, in lacking the stout spines on the maxillary coxae and on coxae I, the internal posterior of the latter being represented only by a boss, and in the less expanded genito-ventral shield which is not so widely separated from the anal shield and on which the 3 pairs of setae are all marginal.

Type *Notolaelaps nova-guinea* sp. nov.

Notolaelaps nova guinea sp. nov.

Fig. 1 A-C

Female Holotype.—Shape broadly oval. Length of idiosoma 520 μ . Dorsal shield entire, not completely covering dorsum but separated marginally by a fairly wide band of cuticle; dorsal setae simple, to 40 μ long. Ventrally; pre-endopodal and jugular shields wanting; sternal shield small, about as wide as long, slightly narrower posteriorly, with 3 pairs of setae and two pairs of pores; metasternal shields only represented by the setae; genito-ventral shield flask-like with 3 pairs of marginal setae and not very widely separated from anal shield; anal shield shortly pear-shaped with the usual 3 setae; between the anal and genito-ventral shields with only one pair of setae and on each side eleven setae; a pair of shortly elongate metapodal shields. Legs slender but not very long, I 325 μ , II 260 μ , III 260 μ , IV 390 μ ; no strong spines on maxillary coxae, a pronounced boss and a slender seta on coxae I, an anterior strong spine and a slender seta on coxae II and III and one seta on coxae IV; tarsi all with short caruncle and paired claws. Peritreme fairly thick with stigmata between coxae III and IV. Chelicerae simple without distinct teeth.

Locality and Host.—Described from the holotype and one paratype female from a small fruit-eating bat, *Syconycteris crassa papuana* Matschie, 1899, from the Jimmi Valley, Western Highlands of New Guinea, 1955 (coll. J. S. Womersley).

* South Australian Museum.

Remarks.—The types of this species are in the South Australian Museum. For the identification of the host I am indebted to Mr. Ellis Troughton of the Australian Museum, Sydney.

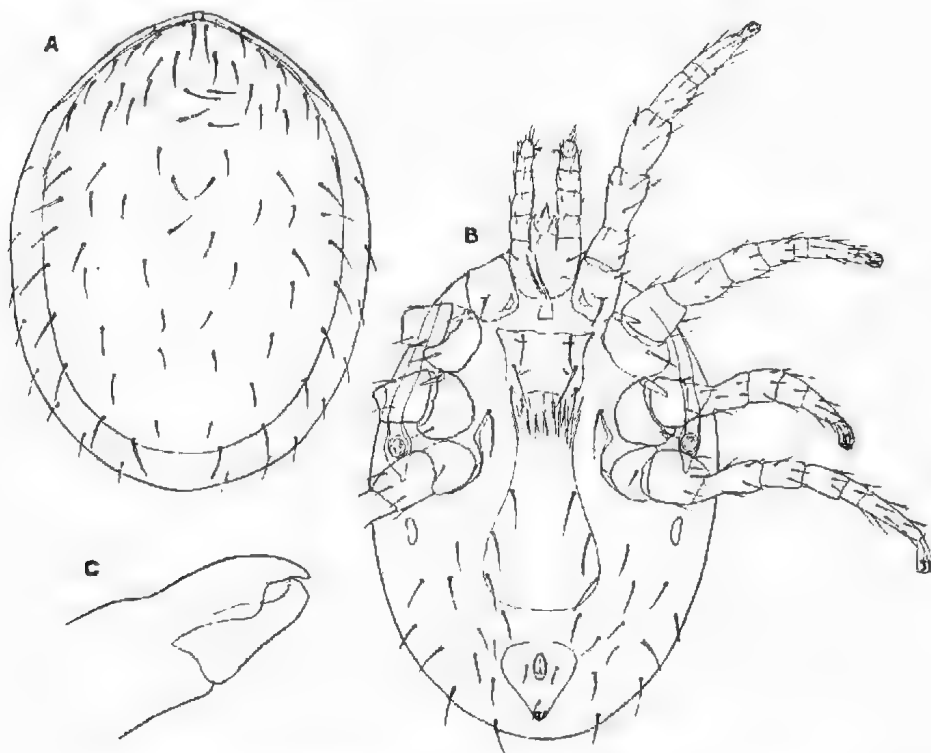


Fig. 1, A-C—*Notolaelaps navaguinea* g. et sp. nov. Female, A, dorsum; B, venter; C, chelicerae.

Genus *Plesiolaelaps* nov.

In adults dorsal shield entire and completely covering dorsum. Labial cornicles slender. Female without pre-endopodal or jugular shields; sternal shield wider than long with 3 pairs of setae; metasternal shield only represented by seta and pore; genito-ventral shield drop-shaped with 5 setae; anal shield rounded; chelicerae without teeth, fixed finger hyaline and thumb-like, movable finger slender and slightly hooked; no specialised armature on coxae or legs. In male with all ventral shields coalesced, moderately expanded behind coxae IV; chelicerae with fixed finger as in female, movable finger hook-like, with a long similarly hook-like spermatophore carrier; legs as in female.

Type *Plesiolaelaps miniopterus* sp. nov.

Plesiolaelaps miniopterus sp. nov.

Fig. 2 A-I

Female Holotype (as mounted in P.V.A.).—Shape oval with slightly flattened sides. Colour light yellowish. Length of idosoma 364μ , width 240μ . Dorsal shield entire, covering the whole dorsum, with light transverse markings and short, 26μ to 32μ long spiniform setae. Venter; as figured, no pre-endopodal or jugular shields; tritosternum lightly chitinised with paired lacinia; sternal shield wider than long, with 3 pairs of slender spiniform setae to 39μ long and

2 pairs of pores; metasternal shields absent, only represented by seta and pore; genito-ventral shield flask- or drop-shaped, rounded apically, with 5 setae (two pairs and a single seta at posterior end), widely separated from anal shield with ca. 3 pairs of setae between these shields; anal shield as figured with 3

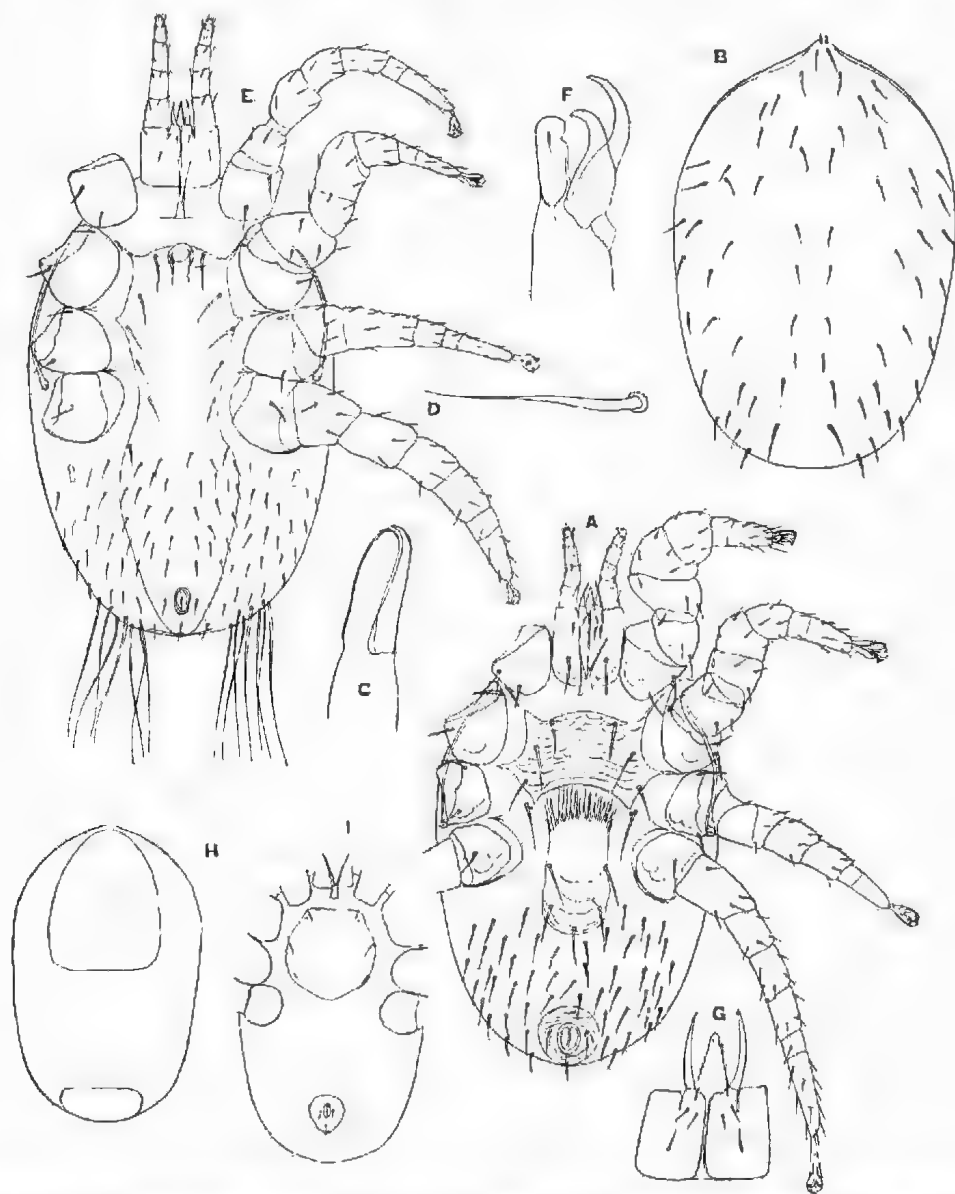


Fig. 2, A-I.—*Plesiolaelaps miniopterus* g. and sp. nov. A-D Female: A, venter; B, dorsum; C, chelicerae; D, dorsal seta. E-G Male: E, venter; F, chelicerae; G, labial cornicles. H-I Protonymph: H, dorsum; I, venter.

setae of which the post-anal is the longest; no metapodal shields could be seen in this sex. Mouth parts small, gnathosoma ventrally with 4 pairs of setae; labial cornicles slender as figured; fixed finger of chelicerae a hyaline thumb-like lobe, movable finger rather slender without teeth. Legs I and II stouter than III and IV, I 227μ long, II 260μ III 227μ , IV 286μ , without specialised setae

or armature, all tarsi with caruncle and paired claws. Peritreme narrow, extending to coxae I.

Male Allotype.—Shape as in female, but in mounted specimen slightly larger. Length of idiosoma 422μ , width 280μ . Legs: I 273μ long, II 234μ , III 247μ , IV 292μ , leg II is the stoutest but has no special armature. Dorsal shield as in female, but the setae are rather shorter to 20μ long. Ventrally, all the shields are coalesced, the genito-ventral portion of the holoventral shield is widest just behind coxae IV; a small lightly sclerotised metapodal shield lies posterior of coxae IV; the setae on the sterno-genital portion of the holoventral shield are 26μ long, while the others on the ventri-anal portion, as are those on the cuticle, are ca. 20μ long, except for a posterior fringe of 7 pairs of long slender setae to 100μ long. Chelicerae as figured, movable finger a strongly chitinated hook with a longer but similarly hooked spermatophore carrier, fixed finger a hyaline blunt thumb-like lobe as in female.

Protonymph.—Shape as in female, but weakly chitinated. Idiosoma 370μ long, 240μ wide. Dorsum with divided shield, anterior part 162μ long by 143μ wide, reaching posteriorly to level between coxae III and IV, its posterior margin widely truncate, posterior part 45μ long and 97μ wide, separated from anterior by about 4 times its own length; dorsal setae 26μ long, except the posterior pair, which are 39μ . Sternal shield as figured, 123μ long by 110μ wide, extending to nearly the middle of coxae IV; leg I 272μ long, II 253μ , III 234μ , IV 266μ . Peritreme very short, 39μ long, and not reaching beyond coxae IV.

Locality and Hosts.—Described from the holotype ♀ and allotype ♂ and paratype of each sex from a bat *Miniopterus schreibersi* (Natterer, 1819), from Joanna, S. Aust., 10th Dec., 1932 (coll. J. Hood). Other specimens from a bat *Nyctophilus geoffreyi* Leach, 1821, from Sutherlands, S. Aust., 23rd Aug., 1955 (coll. E. F. Boehm).

Remarks.—All the specimens are in the South Australian Museum.

This genus differs from all the others in the Laelaptinae in that the female genito-ventral shield has 5 setae arranged in 2 pairs and a single posterior one. It is perhaps nearest to *Radfordilaelaps* Zumpt, 1950, which has 3 genito-ventral setae and a strong knife-like seta on coxae I (not present in *Plesiolaclaps*).

Family MYOBIIDAE Ménézies, 1877

Genus NEOMYOBIA Radford, 1948

Neomyobia luzonensis sp. nov.

Fig. 3 A-J

Female Holotype.—Elongate species. Length of idiosoma 520μ , width 290μ . Dorsum: lateral and submedian setae moderately expanded and longitudinally striated, acuminate, without barbs; lengths, laterals I 97μ , II 162μ , III 195μ , submedian I 65μ , II 97μ , III 65μ . Venter: as in Fig. B, with the inner members of each row of setae slender and much longer than the outer members; there are two other pairs of setae near the caudal margin of which the outer members are long and slender; caudal pairs of setae 360μ long. Legs: I 78μ long, II 130μ , III 162μ , IV 175μ ; I with 4 segments, terminal one with 2 minute claws, otherwise as in genus (Figs. C, D), II-IV with paired claws, one thinner and slightly shorter than the other (Fig. A, E).

Male Allotype.—Length of idiosoma 390μ , width 200μ . Dorsum: lateral and submedian setae as in female, but the third submedians only slightly behind the second and nearer to each other; lengths of laterals I 97μ , II 162μ , III 162μ ; of submedians, I 84μ , II 65μ , III 162μ . Venter: as in Fig. 6 with all the setae short and inconspicuous, between coxae IV with a pair of stout, thick spines, 58μ long, arising from large bosses (in another specimen the right hand spine is duplicated), caudal setae 36μ long. Penis slender, reaching to coxae III and apically recurved. Legs: I 78μ long, II 162μ , III 195μ , IV 182μ ; leg I

as in female; II as in female with subequal paired claws; III (Fig. H) with only one longer and stronger claw and with two stout spurs on tibia; IV with paired unequal claws.

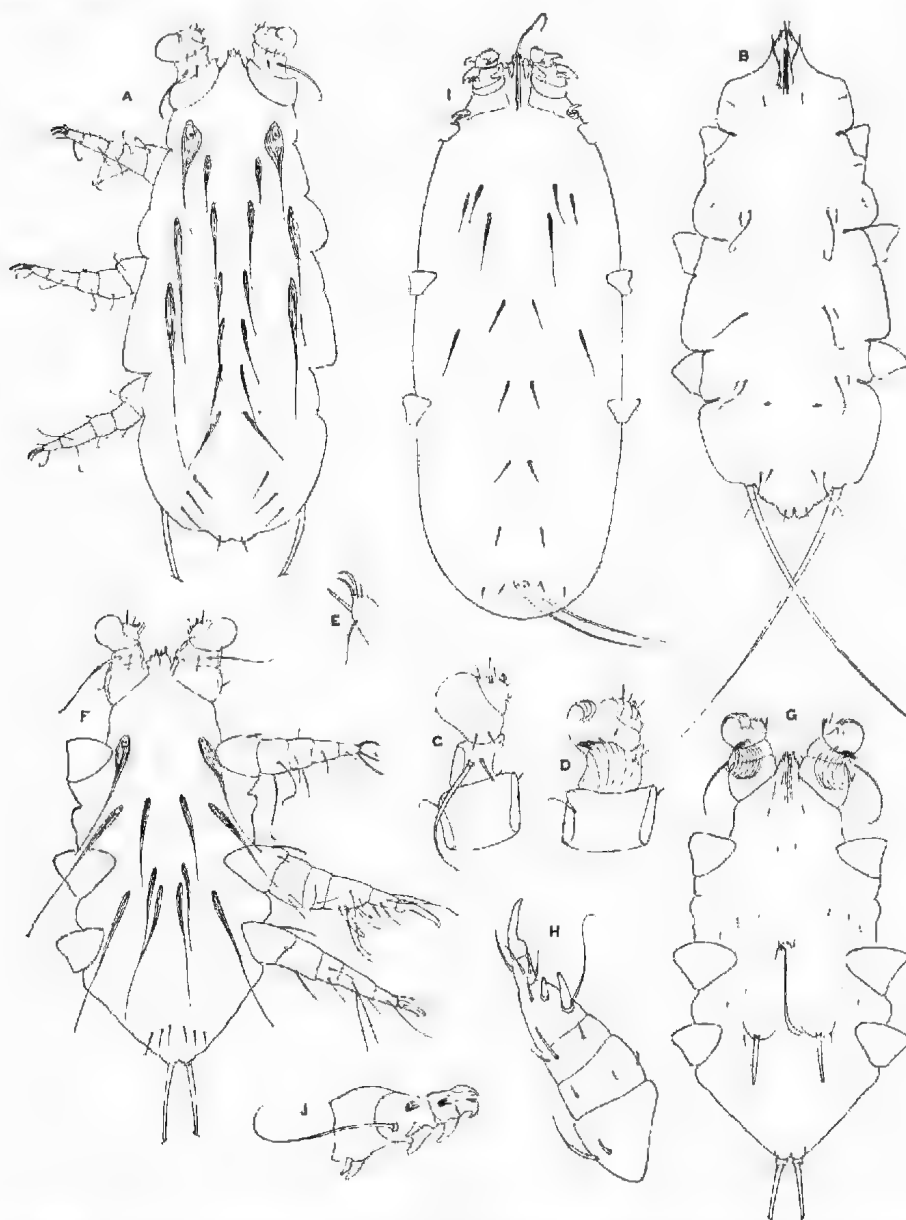


Fig. 3.—*Neomyobia luzonensis* sp. nov. A-E Female: A, dorsal; B, venter; C, leg I dorsal; D, leg I ventral; E, claws of leg II. F-H Male: F, dorsal; G, venter; H, leg III. I-J Nymph: I, dorsum; J, leg I ventral.

Nymph Morphotype.—Length of idiosoma 540μ , width 225μ . Dorsum as in Fig. I; lateral and submedial setae only slightly expanded basally; length of laterals, I 32μ , II 32μ , III 65μ ; of submedian I 65μ , II 32μ , III 80μ ; of caudals 130μ . Legs: I 70μ long, II 84μ , III 91μ , IV 97μ ; leg I as in Fig. J apparently without terminal claws; II with paired tarsal claws, III and IV with only a single tarsal claw.

Locality and Host.—The types and many paratypes from a bat, No. 21a, from Manila, Luzon, 28th March, 1945 (coll. C. B. Philip).

Remarks.—All specimens in S. Aust. Museum. Paratypes later to be distributed to other centres.

In the pair of pronounced stout spines between coxae IV on the venter of the male this species is related to *Neomyobia poppei* (Trouessart, 1895), the type host and locality for which are *Pipistrellus nathusii*. Kays and Blasius, and Marseilles, France. In the male it also differs from *poppei* in that tarsi II and IV have paired claws; according to Radford (Bull. Mus. d'Hist. Nat. Paris (2), 24 (4): 379) *poppei* has but a single claw on tarsi II, III and IV. The tibia of leg III of the male also differs from *poppei* in the presence of the two strong spurs. In the female, *luzonensis* differs little from Radford's figure of *poppei* except in the lesser expansions of the lateral and submedian dorsal setae.

A NEW SPECIES OF TUCKERELLA (ACARINA, TETRANYCHOIDEA, TUCKERELLIDAE) FROM SOUTH AUSTRALIA

BY *H. WOMERSLEY*

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A new species of *Tuckerella* Womersley 1940 belonging to the recently erected family Tuckerellidae (Baker & Pritchard, 1953) is described from *Phyllota* litter from Keith, S.A. A revised key to the three known species is given.

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A new species of *Tuckerella* Womersley 1940 belonging to the recently erected family Tuckerellidae (Baker & Pritchard, 1953) is described from *Phyllota* litter from Keith, S.A. A revised key to the three known species is given.

Baker & Pritchard (Ann. Ent. Soc. Amer., 1953, 16: 243-258) have recently removed the genus *Tuckerella* Womersley 1940 from the Tetranychidae and erected the new family Tuckerellidae to include the two species *pavoniformis* (Ewing, 1922) and *ornata* (Tucker, 1926).

In 1940 Womersley recorded *pavoniformis* wrongly under the name of *ornata* Tucker, as pointed out by Baker & Pritchard. The genus *Tuckerella*, however, was based essentially on Tucker's description and figures, and his species is the nominal type.

In their paper Baker & Pritchard separate the two species *pavoniformis* and *ornata* on the number of pairs of whip-like filamentous caudal setae and also on the last row of four palmate setae on the dorsum.

No further occurrences of *pavoniformis* in Australia have been recorded, but a third and new species described in this paper has recently been found. In many respects it is intermediate between *pavoniformis* and *ornata* as is shown in the following key.

Key to Known Species of *Tuckerella* Wom.

1. Tarsi III and IV with a dorsal sensory rod similar to those on I and II. With 7 pairs of caudal filamentous setae. The four posterior hysterosomal palmate setae small and equal in size.

T. spechtae sp. nov. 2

Tarsi III and IV without such sensory rod
2. With 6 pairs of caudal filamentous setae. Outer members of posterior row of hysterosomal palmate setae larger than the inner members.

T. pavoniformis (Ewing).

With 5 pairs of caudal filamentous setae. All four members of posterior row of hysterosomal palmate setae small and equal in size.

T. ornata (Tucker).

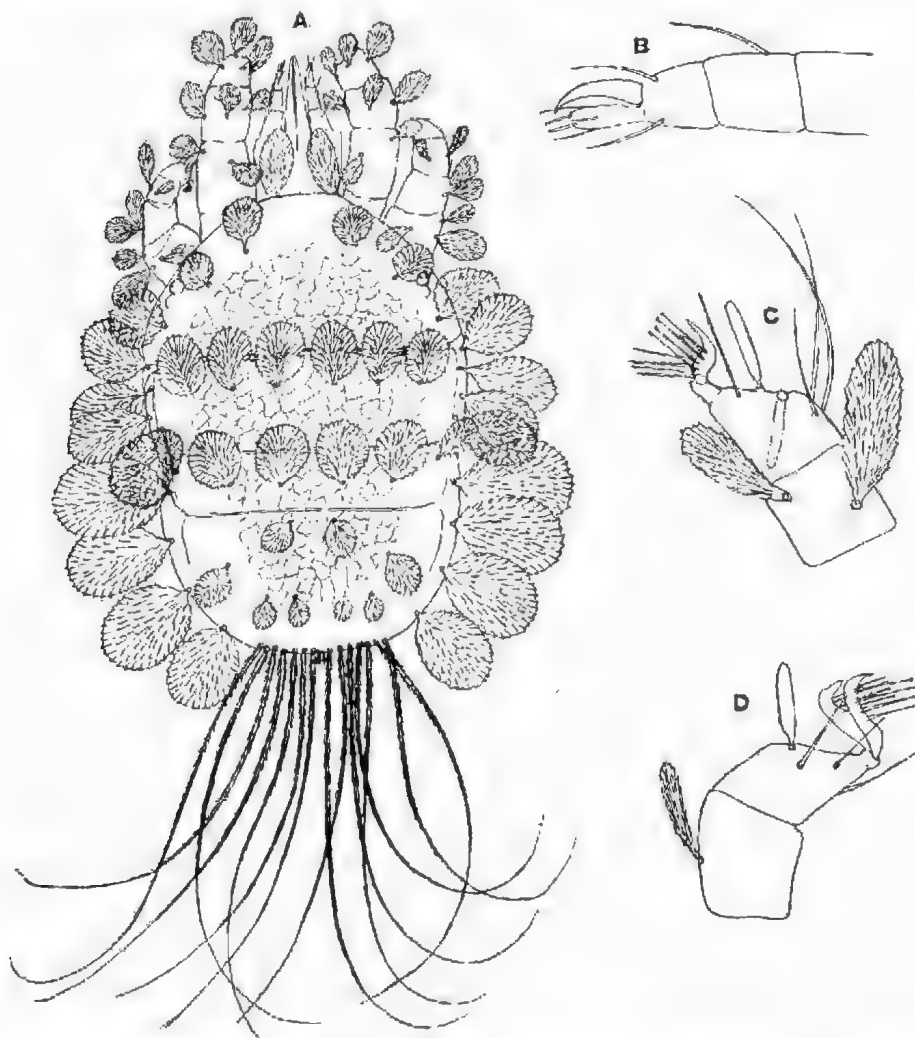
N.B.—In both *ornata* and *spechtae* the two distal sensory rods on tarsi I are about equal in length; in *pavoniformis* the anterior distal sensory rod is very short compared with the posterior distal rod. In the last species tarsus II bears a short antero-distal peg, and leg IV has large, strongly serrate setae dorsally.

* South Australian Museum.

***Tuckerella spechtiae* sp. nov.**

Fig. A-D.

Holotype.—*Female*. Size small. Colour in life red. Length of idiosoma 230μ , width 150μ . Body roundish oval, widest in line of propodosomal-metapodosomal suture. Dorsum strongly reticulated and with suture lines between



Text Fig. A-D.—*Tuckerella spechtiae* sp. nov. A, dorsal view; B, palp; C, tibia and tarsus of leg I; D, same of leg III-IV.

propodosoma and metapodosoma and between the latter and the opisthosoma. Mouth parts elongate with piercing styliform mandibles. Palpi as figured, elongate, four-segmented, tibia with well-developed claw; tarsus cylindrical and barely reaching tip of claw, apparently with 3 setae and two sensory rods. Eyes 2 on each side. Dorsum with 42 palmate or fan-shaped setae as in other species but the four members of the posterior hysterosomal transverse row are all smaller and subequal; with 7 pairs of long, to 200μ , filamentous, shortly ciliated caudal setae; legs short, I 112μ long, II, III and IV 84μ ; furnished with smaller palmate setae; claws strong, furnished with 4 tenent hairs; tarsus I with a pair

of cylindrical sensory rods and 4 simple setae, tarsi II, III and IV each with one such sensory rod. Venter as figured for *pavoniformis* (sic. *ornatus*) Womersley 1940.

Location.—A single female, the type, in the South Australian Museum, collected amongst *Phyllota* litter at Keith, South Australia, July, 1953 (Mrs. M. Specht).

Remarks.—Distinguished from the other known species as in the key.

AUSTRALIAN ACANTHOCEPHALA N° 10

BY S. J. EDMONDS

Summary

Specimens of *Pseudoporrorchis bulbocaudatus* (Southwell and McFie), *Pseudoporrorchis centropusi* (Tubangui) and *Gordiorhynchus hylae* (Johnston and Edmonds) have been re-examined and are considered to be synonymous. The species becomes *Pseudoporrorchis hylae* (Johnston). A new species, *Pseudoporrorchis hydromuris*, is described from the water at, *Hydromys chrysogaster*. *Bolbosoma capitatum* (von Linstow) is recorded from *Globiocephalus melaena* and an acanthocephala from *Canis familiaris dingo* assigned to the genus, *Oncicola*.

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by S. J. EDMONDS*

[Read 14 June 1956]

I. SUMMARY

Specimens of *Pseudoporrorchis bulbocaudatus* (Southwell and McFie), *Pseudoporrorchis centropusi* (Tubangui) and *Gordiorhynchus hylae* (Johnston and Edmonds) have been re-examined and are considered to be synonymous. The species becomes *Pseudoporrorchis hylae* (Johnston). A new species, *Pseudoporrorchis hydromiris*, is described from the water rat, *Hydromys chrysogaster*. *Bolbosoma capitatum* (von Linstow) is recorded from *Globiocephalus melaena* and an acanthocephala from *Canis familiaris dingo* assigned to the genus, *Oncicola*.

II. INTRODUCTION

This paper deals with four acanthocephala, one of which is new.

PARASITE	HOST
<i>Pseudoporrorchis hylae</i> (Johnston)	{ <i>Centropus phasianinus</i> (Latham) <i>Podargus strigoides</i> (Latham)
<i>Pseudoporrorchis hydromiris</i> n. sp.	<i>Hydromys chrysogaster</i> (Geoffroy)
<i>Bolbosoma capitatum</i> (von Linstow)	<i>Globiocephalus melaena</i> (Traill)
<i>Oncicola</i> sp.	<i>Canis familiaris dingo</i> (Blumenbach)

III. DESCRIPTION OF PARASITES

1. *Pseudoporrorchis hylae* (Johnston)

Synonymy

Echinorhynchus hylae Johnston, 1912.

Pseudoporrorchis bulbocaudatus (Southwell and McFie, 1925).

Pseudoporrorchis centropusi (Tubangui, 1933).

Gordiorhynchus hylae (Johnston and Edmonds, 1948).

Discussion

Johnston and Edmonds (1948) identified an acanthocephalan parasite from *Podargus strigoides* as *Gordiorhynchus hylae*. This was an error; it should have been assigned to the genus, *Pseudoporrorchis* Joyeux and Baer, 1935. The authors were misled by the facts (1) that both male and female worms possessed internal pseudosegmentation, and (2) that a small appendix was present near the female genital aperture—both characters of the genus, *Gordiorhynchus* Meyer, 1931. The authors did state that because the receptaculum did not divide the introvert into two parts the conception of the genus would have to be enlarged to include the specimens from *Podargus*. At the time internal pseudosegmentation had not been described for any of the species of *Pseudoporrorchis*.

During 1952 the present author had the opportunity of examining at the British Museum of Natural History some of Southwell and McFie's specimens of *Pseudoporrorchis bulbocaudatus* from *Centropus phasianinus*. At once it was obvious that (1) this species possesses internal pseudosegmentation, a fact not recorded by Southwell and McFie, and (2) *Gordiorhynchus hylae* is synonymous with *P. bulbocaudatus*. Further, through the kindness of the late Professor H.

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Van Cleave, five slides of *Pseudoporrorchis centropusi* (Tubangui, 1933) — all named by Tubangui — were made available for re-examination. A study of these specimens showed that the range of measurements of some organs and structures of *P. centropusi* could be extended, e.g. (1) the length of the male may be as long as 21 mm. and the female 28 mm., (2) the introvert is armed with 26 longitudinal rows of 8-10 hooks per row, and (3) ripe eggs about $50\ \mu \times 23\ \mu$ are present in one female. In addition, internal pseudosegmentation is present and the female aperture is subterminal. This extra information brings Tubangui's specimens from *Centropus viridis* into the synonymy of *P. bulbicaudatus*.

Johnston and Edmonds (1948) identified the parasite from *Podargus strigoides* as the adult of a larval form encysting in the mesentery of a number of Australian frogs (*Hylas* spp. and *Limnodynastes* sp.) and named by Johnston (1912) as *Echinorhynchus hylae*. A further examination of the introverts of a large number of larvae from frogs has confirmed this fact. If the rules of priority in nomenclature are followed, the parasites from *Centropus viridis*, *Centropus phasianinus* and *Podargus strigoides* become *Pseudoporrorchis hylae* (Johnston).

Pseudoporrorchis houdmeri Joyeux and Baer, 1935, the type-species of the genus, from *Centropus sinensis intermedius* is a closely related species. It is armed with 22-24 longitudinal rows each of 11-12 hooks.

The occurrence of internal pseudosegmentation has now been recorded in at least three different genera of the Acanthocephala; (1) *Gordiorhynchus* Meyer, 1931, (2) in the present paper in some species of *Pseudoporrorchis*, and (3) in some species of *Arhythmorhynchus* by Van Cleave (1916, p. 171 and fig. 8)

2. *Pseudoporrorchis hydromuris* n. sp.

figs. 1-4.

Seven female and two male specimens were found in the small intestine of the Australian water rat, *Hydromys chrysogaster*, at Innisfail, Queensland, by Mr. N. C. Elliot (10/10/55) and forwarded for identification by Dr. J. M. Mackerras of the Institute of Medical Science, Queensland.

Description.—The length of the males is 14-17 mm. and of the females 12-19 mm. The trunk is cylindrical but tends to taper slightly towards the anterior and posterior extremities. The maximum width, occurring in the anterior third of the trunk, is 1.1-1.5 mm. in the male and 1.5-2.2 mm. in the female. The introvert is relatively small and almost spherical in shape. It is 0.40-0.46 mm. in diameter and is armed with about 26 longitudinal rows each of 7-8 hooks per row. The second or third hook of each row is largest and possesses a well developed posteriorly directed rooting process. The length of the projecting portion of the largest hook is (40-50) μ and of the rooting process about (60-70) μ . In hooks 5, 6, 7 and 8 the posteriorly directed rooting process progressively decreases in size and an anteriorly directed process appears and progressively increases in size. A similar condition has been described for *Pseudoporrorchis hylae* by Johnston and Edmonds (1948) and for *Pseudoporrorchis teliger* by Van Cleave (1949). There is a tendency for the extremities of the rooting processes of *P. hydromuris* to be swollen slightly. Delicate wing processes, however, like those so carefully described by Van Cleave for *P. teliger* could not be distinguished. There is a short neck about 0.2 mm. long which in all specimens lies within the anterior end of the trunk. The introvert sheath, 1.1 mm. long and 0.35 mm. wide, is double walled and arises just posterior to the last whorl of introvert hooks.

Two ellipsoidal testes, 1.1-1.8 mm. long and 0.6-0.8 mm. wide lie in tandem within the anterior third of the trunk. There are six long tubular cement glands pressed closely together. The posterior extremity of the female is rounded but

not swollen and does not bear an appendix like *P. hylae*. The female aperture is terminal. Ripe eggs are ellipsoidal in shape and their outer shell is thick. They are 68-75 μ long and 32-36 μ wide and do not possess polar prolongations. Longitudinal sections of both male and female reveal that internal pseudosegmentation, like that of *P. hylae*, is present in both sexes.

Systematic Position.—This species is morphologically very close to and was at first thought to be identical with *Pseudoporrorchis hylae* from the birds *Centropus viridis* and *C. phasianinus*. It differs, however, in a number of respects. The introvert of *P. hydromuris* is globose or subspherical and slightly smaller than that of *P. hylae*, which is clavate. The number of hooks in each longitudinal row is less in *P. hydromuris* than *P. hylae*. Further, the posterior extremity of the females of *P. hylae* is swollen into a bulb-like structure which bears a small appendix. This condition does not occur in any of the specimens of *P. hydromuris*.

This is the second record of a mammal as a definitive host of a species of *Pseudoporrorchis*, a genus usually found in birds. Van Cleave (1949) described *P. teliger* from a mongoose, *Herpestes javanicus* and from *Felis minutus javanicus*. *P. teliger* and *P. hydromuris*, although closely related, differ significantly in the number of hooks on the introvert.

Type specimen.—S.A. Museum, Adelaide.

3. *Bolbosoma capitatum* (von Linstow, 1880)

Four female and one male specimen of this parasite were obtained from the intestine of *Globiocephalus melas* stranded at Prime's Beach, St. Vincent Gulf, S.A., by the late Professor T. H. Johnston on 7/10/44.

Description.—The females are 6.0-8.5 cm. long and 2-3 mm. wide and the male is 3.2 cm. long and about 1.8 mm. wide. The anterior region of the trunk tapers to a fine neck 2-4 mm. long and less than 1 mm. wide. Anteriorly, the neck is surmounted by a prominent swelling or bulb, rather flattened in most specimens and about 1.5-3.0 mm. wide and 1.2-2.1 mm. in length. Arising from the bulb is a small cylindrical introvert which is expanded, and then not quite fully, in one specimen only. It is 0.4 mm. wide at its base and would be about 0.7-0.8 mm. long. It is armed with 14-16 longitudinal rows of hooks. Each row contains probably 8 hooks. The anterior—most hooks are stoutest, largest and most curved; those posteriorly are more pointed and less curved. The bulb itself is covered with stout, densely packed spines, larger than those on the introvert.

The neck and bulb in most specimens is curved ventrally to the long axis of the trunk and the posterior extremity dorsally to some extent. This condition is shown for *B. capitatum* in Meyer's monograph (Meyer, 1932, fig. 66). The posterior region of the trunk of all specimens forms an introvert.

The testes of the male are in the anterior fourth of the trunk just behind the region of the neck. They are ellipsoidal in shape, about 2.5 mm. long and 0.8 mm. wide. Ripe eggs are spindle-shaped and measure (140-162) $\mu \times$ (28-31) μ . They possess long polar prolongations of the middle shell.

Systematic Position.—These specimens are considered to be *B. capitatum* described from *Globiocephalus melas* by von Linstow (1880). The bulb of the South Australian specimens is not quite as extended as those described by von Linstow. The eggs in the female are considerably larger than those described for the species by Porta (Meyer, 1931, p. 90). Otherwise the correspondence with Linstow's details is close. The specimens differ from *B. hamiltoni* Baylis, 1929 in the armature of the introvert where the number of longitudinal rows is 26, nearly double the number in *B. capitatum*.

4. *Oncicola* sp.

fig. 5

Five acanthocephalan specimens, four of which were decapitated, were forwarded for identification from the Institute of Medical and Veterinary Science, Adelaide. The parasites were obtained from *Canis familiaris dingo* from Central Australia and have been recorded as *Oncicola* sp. by Banks (1952) in a list of parasites from the Northern Territory. Some descriptive details are given in the present paper.

Description.—The length of the trunk of the females is 10-14 mm. and the maximum width in the anterior third of the animal is 1.2 mm. The body tapers gradually towards the posterior extremity which is curved dorsally to some extent. The trunk of the only male is 5 mm. long and stouter than the females. The introvert (belonging to a female) is rounded or globular, 0.55 mm. long and with a maximum width of 0.5 mm. At the base it is about 0.4 mm. wide. It is armed with 6 spiral rows each of 6 hooks. The anterior hooks are largest and strongest and possess anteriorly directed rooting processes. The testes lie side by side and the cement glands are pressed closely together into a compact mass. Ellipsoidal-shaped eggs, with a slightly irregular-shaped outer membrane, are present in the body cavity of two specimens; they measure (97-105) $\mu \times$ (55-60) μ .

Systematic Position.—Several species of acanthocephala have been reported from *Canidae* in other parts of the world; (1) *Oncicola canis* (Kaupp) from *Canis familiaris* from N. and S. America (summarized by Filho, 1940) and from *Canis latrans texensis* (Price, 1928); (2) *Oncicola* sp. from "native dog," Philippine Is. by Tubangui (1933); (3) *Pachysentis canicola* Meyer from *Canis* sp., Brazil (Meyer, 1932); (4) *Pachysentis procumbens* Meyer from *Canis vulpecula*, Egypt (Meyer, 1932); (5) *Pachysentis ehrenbergi* Meyer from *Canis vulpecula*, Egypt (Meyer, 1932); (6) *Echinopardalis atrata* Meyer from *Canis vulpecula*, Egypt (Meyer, 1932); and (7) *Echinorhynchus pachyacanthus* Sonsino from *Canis aureus*, Egypt (Meyer, 1932); and (8) *Macracanthorhynchus catulinus* Kostylew from *Canis familiaris*, Turkestan (Meyer, 1932). Of all these species the specimens from the dingo resemble most *Oncicola* sp., as described by Wittenberg (1938). Consequently, they have been assigned for the time to the genus, *Oncicola*.

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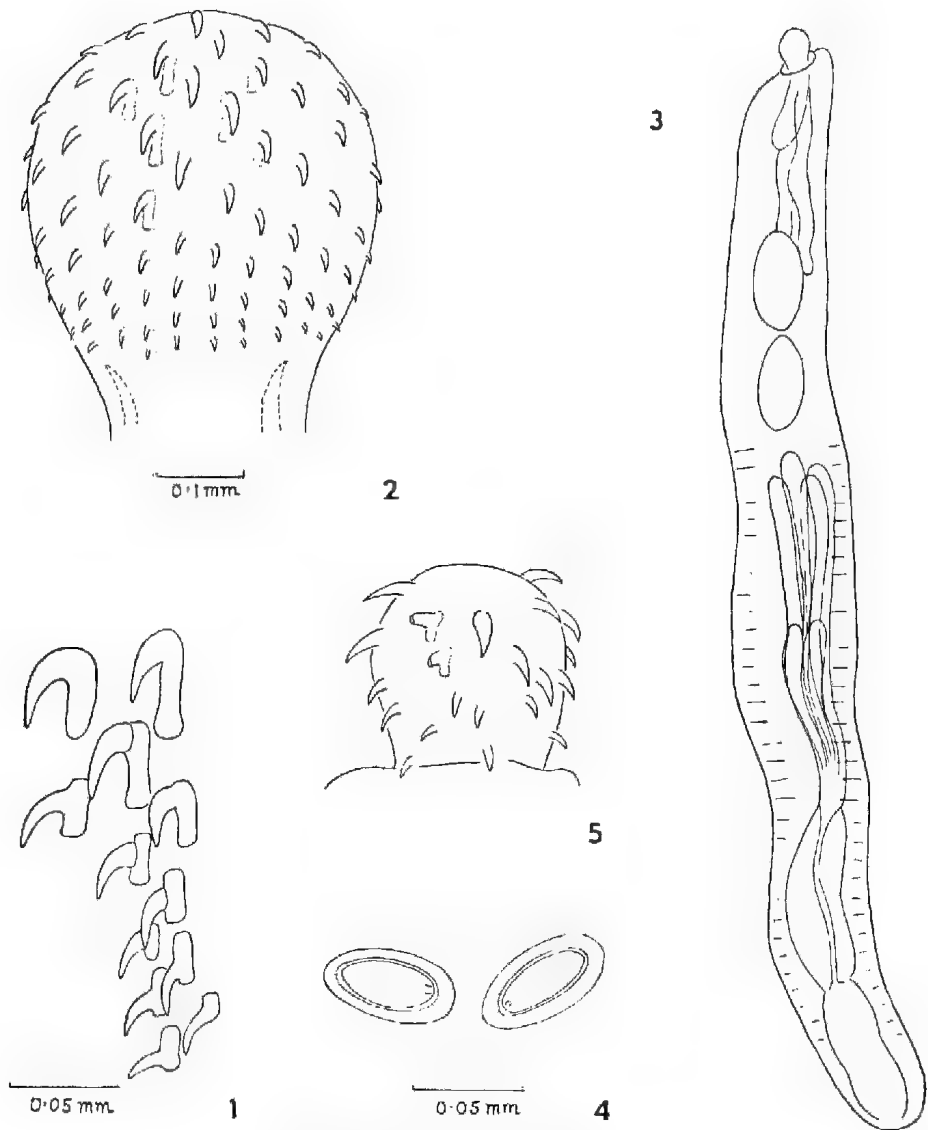


Fig. 5.—*Oncicola* sp. Introvert.

Figs. 1-4.—*Pseudoprororchis hydromuris*. 1, Hooks from introvert. 2, Introvert. 3, Male. 4, Eggs.

THE COCCOIDEA (HOMOPTERA) NATURALIZED IN SOUTH AUSTRALIA: AN ANNOTATED LIST

BY HELEN M. BROOKES

Summary

This paper brings together previously published records of scale insects that have become naturalized in South Australia; it does not consider indigenous species. It also includes species identified by the author, but not previously recorded as occurring in the State. Of these, *Odonaspis ruthae* Ehrhorn, *Pseudococcus malacearum* Ferris, *Tridiscus distichlii* (Ferris), and *Eriococcus coccineus* Cockerell, are reported from Australia for the first time. A list is also given of species identified from material submitted by quarantine services in this State.

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INTRODUCTION

Towards the end of the 19th century several workers made collections of Australian Coccoidea and described many new species. The first catalogue of the Australian scales was published by Maskell (1895), which was followed by that of Lidgett (1899). Froggatt (1914-1921) produced a series of papers in the Agricultural Gazette of New South Wales, which contained descriptions of new species and also referred to some exotic scales known to be established in Australia. This monograph was reprinted, with some additions, as Science Bulletins Nos. 14, 18 and 19 of the Department of Agriculture of New South Wales. Few specific references exist in the literature to scales occurring in South Australia.

This paper lists the introduced scales identified by the writer in the course of several years' work with the group. Most of these had not been reported previously from South Australia, and four species appear to be new to Australian records. In addition, some earlier published references have been included. Notes on hosts and economic status are given. A list is also appended of scales upon imported plants and fruit, and which were submitted for identification by quarantine authorities.

The classification used is that of Ferris (1950a, 1955a). Where available, the following citations are given for each species: the original description; its first recorded occurrence in Australia; the first recorded occurrence in South Australia; and the most recently used synonym in the Australian literature. The common names are those used in Gay's list (1955).

Specimens were examined after treatment with 10 per cent. aqueous potassium hydroxide, and staining with basic or acid fuchsin; they were mounted in "Sira", a neutral synthetic medium, or in Mohr and Wehrle's medium.

Family DIASPIDIDAE

Aonidiella aurantii (Maskell, 1879)

Aspidiotus aurantii Maskell, 1879. Trans. N.Z. Inst., 11, p. 199. On oranges and lemons imported into New Zealand from Sydney.

Aspidiotus aurantii Mask. Anon., Rep. Minister of Agric., S. Aust., 1912-1913.

Chrysomphalus aurantii Maskell. Davidson, J., 1931. J. Dep. Agric., S. Aust., 34, p. 744. Recorded at Berri in 1929.

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RED SCALE

Host-plants:

Aonidiella aurantii (Mask.) is the commonest scale on *Citrus* spp. in this State. It occurs on the leaves and fruit throughout the year. In commercial orchards of the irrigated areas of the Lower River Murray Valley it has become a serious pest. In some of these orchards a few isolated trees of *Juglans regia* L. (walnut) and *Prunus domestica* L. (European plum) at Younghusband, and *Pyrus communis* L. (pear) at Mypolonga have become heavily infested with *A. aurantii*. In the citrus orchards of the Upper Murray Valley red scale is confined to restricted outbreak areas by means of regular, drastic control measures (Botham, 1955).

A. aurantii has been identified from the following additional hosts in South Australia: *Coprosma retusa* Petrie (looking-glass plant), *Foeniculum vulgare* Hill (fennel), *Ilex aquifolium* L. (English holly), *Laurus nobilis* L. (laurel), *Rosa* spp. (cultivated roses) *Pyrus malus* L. (apple), and *Vitis vinifera* L. (grape-vine).

Aonidiella citrina (Coquillett, 1891)

Aspidiotus aurantii var. *citrina* Coquillett, 1891. U.S.D.A., Div. Ent., Bull. 23, pp. 19-30.

Aspidiotus citrina Coquillett, Anon., 1940. Agric. Gaz. N.S.W., 51 (6), p. 346.

On *Citrus* in the coastal regions of New South Wales where it has been known for several years as a form of *A. aurantii*.

YELLOW SCALE.

Host-plants:

Aonidiella citrina was first recognized in South Australia in 1946 at Waikerie, on the River Murray. It was found on leaves and fruit of *Citrus grandis* Osbeck (grape fruit) and *Citrus sinensis* Osbeck (Valencia orange). The leaves of a grape-vine that were in contact with the orange were also infested. At Berri, Loxton and Mypolonga it occurred on the leaves and fruit of orange. After treatment of these localized outbreaks *A. citrina* was not seen in South Australia until June, 1956, when specimens were identified from an occurrence involving a single orange tree at Waikerie.

Aspidiotus hederae (Vallot, 1829).

Chermes hederae Vallot, 1829. Mem. Acad. Dijon, pp. 30-33, 1829. [Not seen.]

Aspidiotus nerii Bouché. Maskell, W. M., 1882. Trans. N.Z. Inst., 14, p. 217. On *Citrus*, oleander and *Acacia* from all States of Australia.

Aspidiotus hederae Vallot. Froggatt, W. W., 1914. Agric. Gaz. N.S.W., 25 (4), p. 314.

This species was reported to infest all kinds of plants, shrubs and forest trees. Although lemons imported from Italy into Sydney were heavily infested, Froggatt had never seen *A. hederae* in an orchard.

OLEANDER SCALE.

Host-plants:

In South Australia this scale is commonly found on *Citrus* spp., both in commercial orchards and home gardens; *C. grandis* Osbeck (fruit), Berri and Waikerie; *C. sinensis* Osbeck (fruit), Berri, Holder and Renmark. Other observed hosts include *Olea europaea* L. (olive), Glen Osmond; *Nerium oleander* L. (oleander), Glen Osmond; *Ribes rubrum* L. (red currant), Stirling West; *Ceratonia siliqua* L. (carob), Waikerie; *Morus nigra* L. (mulberry), Renmark.

A. hederae is not regarded as a serious pest. It may cause persistent green patches around scales on ripening citrus fruits.

Aulacaspis rosae (Bouché, 1834)

Aspidiotus rosae Bouché, 1834. Naturgeschichte der Insekten. Erste Lieferung, 1-5, pp. 1-216. Nicolai, Berlin. [Not seen.]

Diaspis (*Aulacaspis*) *rosae* Bouché. Froggatt, W. W., 1914. Agric. Gaz. N.S.W., 25 (10), p. 881.

ROSE SCALE.

Host-plant:

Rosa spp. On cultivated roses (stems) in the Adelaide district, but appears to cause little, if any, damage.

Diaspis boisduvali (Signoret, 1869)

Diaspis boisduvali Signoret, 1869. Ann. Soc. Ent. Fr. (4), 9, p. 432.

Diaspis boisduvali Signoret, Maskell, W. M., 1895. Trans. N.Z. Inst., 27, p. 44. On *Cattleya* sp. and *Dendrobium* sp. in a hot-house at Adelaide.

Host-plant:

On orchid bulbs at Adelaide, 1951.

Ischnaspis longirostris (Signoret, 1882)

Mytilaspis longirostris Signoret, 1882. Bull. Soc. ent. Fr., pp. 35-36. [Not seen.]

Ischnaspis filiformis Douglas. Maskell, W. M., 1895. Trans. N.Z. Inst., 27, p. 52. On palms in hot-houses at Adelaide.

This appears to be the only reported occurrence of this scale in South Australia; it has not been seen by the author.

Lepidosaphes beckii (Newman, 1869)

Coccus beckii Newman, 1869. Entomologist, 4, p. 217. [Not seen.]

Mytilaspis citricola Packard. Green, E. E., 1914. Bull. ent. Res., 5, p. 233. On *Citrus acida* Roxb. (lime) at Botanic Gardens, Darwin, Northern Territory.

PURPLE SCALE.

Host-plants:

This species occurs mainly on *Citrus* spp. in New South Wales and Queensland. Froggatt (1914b) states that Maskell identified purple scale as *Mytilaspis citricola* on *Croton* sp. from Adelaide. It has not been found by the writer. *Croton* is grown in Adelaide as a hot-house plant.

Lepidosaphes tokionis (Kuwana, 1902)

Lepidosaphes newsteadi var. *tokionis* Kuwana, 1902. Proc. Calif. Acad. Sci. (3), 3 (2), pp. 43-98. [Not seen.]

Mytilaspis auriculata Green. Froggatt, W. W., 1914. Agric. Gaz. N.S.W., 25 (7), p. 606. On *Croton* sp. in the Botanic Garden, Adelaide. Recorded from South Australia only on the basis of this report; not seen by the writer.

Lepidosaphes ulmi (Linnaeus, 1758)

Coccus ulmi Linnaeus, 1758. Syst. Nat. Ed. 10, 1, p. 455. [Ferris (1937) states that the synonymy of this species is much confused; briefly, it is *Coccus ulmi* of Linnaeus; *Aspidiotus pomorum* of Bouché, which became *Mytilaspis pomorum* (Bouché) of Signoret and later authors.]

Mytilaspis pomorum (Bouché). Fuller, C. W., 1899. Trans. ent. Soc. Lond., 1899, pp. 435-473. On apple, Mt. Barker, Western Australia.

Lepidosaphes ulmi Linn. Davidson, J., 1931. J. Dep. Agric. S. Aust., 34, p. 744. Recorded on old apple trees in the Mount Gambier district.

MUSSEL SCALE.

Host-plant:

Pyrus malus L. (apple). Froggatt (1914a) implied that mussel scale was present in South Australia when he stated that it was "all over the orchards of Australia, found usually upon the bark or trunk of the tree or the young branches . . ." In July, 1954, *L. ulmi* was identified from Crafrers, Mt. Lofty Ranges; this was a heavy infestation of the fruit of one tree. Mussel scale is reported to be confined to a few gardens in the cooler districts, where it is not a pest. (Anon., 1940.)

Odonaspis ruthae Ehrhorn, 1907

Odonaspis ruthae Ehrhorn, 1907. 2nd. Bienn. Rep. Hort. Calif., p. 26. [Not seen.]

Odonaspis ruthae Ehrhorn. Balachowsky, A. S., 1953. Les Cochenilles, 7, p. 21. Hermann, Paris.

Host-plants:

Cynodon dactylon (L.) (couch grass), Adelaide (1952); Wallaroo. The scale is distributed over the sheathing leaf-bases, stolons and roots, *Sorghum halipense* (L.) (Johnson grass), Adelaide.

This is the first record of *O. ruthae* in Australia.

Quadraspidotus ostreaeformis (Curtis, 1843)

Aspidiotus ostreaeformis Curtis, 1843, Gard. Chron., 3, p. 805. [Not seen.]

Aspidiotus ostreaeformis. Evans, J. W., 1942. Tasim. J. Agric. 13 (4), p. 158. On apple and other hosts in Tasmania.

OYSTER-SHELL SCALE.

Host-plant:

Pyrus malus L.

Quadraspidotus ostreaeformis was identified for the first time in South Australia from Cudlee Creek in May, 1948; field observations indicate that it is well established and presumably has been present for many years. It was later seen to be lightly but widely distributed on the bark of apple trees in commercial orchards in the Mount Lofty Ranges. In 1954, a heavy infestation was seen at Balhannah; this was confined to the older limbs of two trees (Granny Smith variety) about twenty years old, and had apparently killed the affected limbs. *Q. ostreaeformis* occurs occasionally on twig-growth and fruit, but principally on old trees, sheltering beneath surface bark.

An allied species, *Quadraspidotus perniciosus* (Comstock), the San José scale, is not known to occur in South Australia although references have occasionally been made in the Australian literature to its presumed occurrence here. Froggatt (1914c) inferred its presence in this State when he recorded *Aspidiotus perniciosus* as a serious pest on bark, foliage and fruit of pome and stone fruits. He stated that it "has been spread all over the Australian States with nursery stocks". Maskell (1896) recorded a heavy infestation of *A. perniciosus* on twigs of *Eucalyptus corynocalyx* collected at Adelaide. However, Cockerell (1897) stated, with reference to South Australia that he was "quite convinced that the supposed variety of *perniciosus* recorded by Maskell as on *Eucalyptus* in Australia is not that insect; the description reads more like *A. forbesi*, but it is very likely something else". A comprehensive bibliography of San José scale in Australia between 1892 and 1898 is given by Tryon (1898).

Family COCCIDAE (LECANIIDAE)

Coccus hesperidum Linnaeus, 1758

Coccus hesperidum Linnaeus, 1758. Syst. Nat. 10th Ed., p. 455.

Lecanium hesperidum Linnaeus. Maskell, W. M., 1893. Trans. N.Z. Inst., 27, p. 15. On *Citrus* and *Laurus* in Australia.

Lecanium hesperidum Linn. Davidson, J., 1931. J. Agric. S. Aust., 34, p. 744. On orange trees at Gawler, South Australia, in 1929.

SOFT BROWN SCALE.

Host-plants:

Coccus hesperidum is widely distributed on *Citrus* spp. in South Australia. It has a wide range of hosts, especially cultivated plants. It has been identified on *Sideroxylon australis* Benth. et Hook (scrub crab-apple) at the Waite Institute Arboretum. Green (1904) considers that his species *Lecanium signiferum* differs from *C. hesperidum* principally in coloration and may be merely a well-marked variety. This form of *C. hesperidum* was identified on *Eugenia pendula* D.C. (lilly-pilly), *Laurus nobilis* L. and *Sideroxylon australis* at the Waite Institute.

***Eucalymnatus tessellatus* (Signoret, 1873)**

Lecanium tessellatum Signoret, 1873. Ann. Soc. Ent. Fr. (5) 3, pp. 395-446.
Lecanium tessellatum Signoret. Maskell, W. M., 1893. Trans. N.Z. Inst., 25, p. 219. On *Laurus nobilis* at Sydney, New South Wales. Maskell, W. M., 1895. Trans. N.Z. Inst., 27, pp. 35-75. On palms in hot-houses, Adelaide, South Australia.

Host-plants:

In the Adelaide district *E. tessellatus* has been identified from *Brachychiton* spp., *Ilex aquifolium* L., *Sterculia* sp., and on *Phoenix humilis* Royle at the Botanic Garden, Adelaide. It is of no economic importance under South Australian conditions.

***Eulecanium persicae* (Fabricius, 1776)**

Lecanium berberidis Schrank. Maskell, W. M., 1897. Trans. N.Z. Inst., 29, p. 311. On grape-vines at Melbourne, Victoria.
Lecanium persicae F. Anon., 1940. J. Dep. Agric., S. Aust., 43 (9), p. 640. On grape-vines in South Australia.

VINE SCALE.

Host-plants:

Of widespread occurrence on *Vitis vinifera* L.; *Parthenocissus tricuspidata* Planch (Virginia creeper) and *Hedera helix* L. (ivy) at Adelaide. The adult female scales of *E. persicae* are usually found to be heavily parasitized by wasps.

***Eulecanium pruinorum* (Coquillett, 1891)**

Lecanium pruinorum Coquillett, 1891. Insect Life, 3, pp. 382-384.
Lecanium pruinorum. Anon., 1935. Agric. Gaz. N.S.W., 46 (6), p. 328.
Eulecanium pruinorum. Anon., 1948. Insect Pest Survey for 1948, N.S.W. Dep. Agric., pp. 5, 7, 9.

FROSTED SCALE.

Host-plants: The soft stone-fruits.

This species was identified in South Australia for the first time in October, 1954. It was found on the wood of plum trees in several orchards in the Mount Lofty Ranges. At Ballanah at least three trees in one orchard were heavily infested, there being about 25 adult females per foot of branch. In the Barossa district, north of Adelaide, the scales were densely clustered along the spurs of apricot trees during November when eggs were being laid. *E. pruinorum* was not reported as a pest from these areas during the following year.

***Saissetia hemisphaerica* (Targioni-Tozzetti, 1867)**

Lecanium hemisphaericum Targioni-Tozzetti, 1867. Mem. Soc. italiana Sci. Nat. 3 (3), pp. 1-81. [Not seen.]
Lecanium hemisphaericum: Maskell, W. M., 1895. Trans. N.Z. Inst., 27, p. 59. On *Eranthemum variegatum* at Adelaide.
Saissetia coffeae Walker. Anon., 1951. Insect Pest Survey for 1951, N.S.W. Dep. Agric.

HEMISPHERICAL SCALE.

Host-plants:

Asplenium sp., *Eranthemum variegatum* at Adelaide, *Cycas revoluta* Thunb. at the Botanic Garden, Adelaide. In this State *S. hemisphaerica* is principally a pest of ferns in shade-houses.

***Saissetia nigra* (Nietner, 1861)**

Lecanium nigrum Nietner, 1861. Ceylon Times, p. 9 (1861). [Not seen.]
Lecanium nigrum Nietner var. *depressum*, Maskell, W. M., 1894. Trans. N.Z. Inst., 26, p. 73.
Saissetia nigra. Simmonds, H. W., 1951. J. Dep. Agric. S. Aust., 54 (8), p. 398.

NIGRA SCALE.

Host-plants:

Daphne odora Thunb. and *Nerium oleander* L. at Adelaide; *Ilex aquifolium* L. in the Adelaide district and Mt. Lofty Ranges; *Osteospermum moniliferum* L., National Park, Belair.

Saissetia oleae (Bernard, 1782)

Chermes oleae Bernard, 1782. Mem. d'Hist. Nat. Acad., Marseille, p. 108 (1782). [Not seen.]
Lecanium oleae Bern. Froggatt, W. W., 1897. Agric. Gaz. N.S.W., 8, p. 532. Recorded as
a common species in Sydney gardens.
Saissetia (*Lecanium*) *oleae* Bern. Quinn, G., 1916. J. Dep. Agric. S. Aust. 19 (11), p. 979.
On orange in South Australia.

BLACK SCALE.

Host-plants:

Citrus spp. Quinn (*loc. cit.*) first recorded *S. oleae* in South Australia as a pest on the leaves and woody parts of orange trees. It may become numerous enough to cause loss of fruit in commercial orchards. In the Adelaide district small, localized outbreaks, sometimes severe, may occur from time to time.

Simmmonds (1951) described the life-history of *S. oleae* in South Australia and discussed the part played by predators and parasites in limiting the numbers of black scale on *Citrus* and *Olea europea* Linn. (olive).

Black scale has been identified in the Adelaide district on *Nerium oleander* L., *Duranta plumieri* Jacq. (sky-flower), *Crataegus* sp. (hawthorn), *Erica* sp. (heath), *Sterculia* sp., *Hedera helix* L., *Calodendrum capense* Thunb. (Cape chestnut), *Solanum nigrum* L. (nightshade), and *Wahlenbergia gracilis* (Forst. f.) A.D.C. (Australian bluebell).

Family PSEUDOCOCCIDAE

Planococcus citri (Risso, 1813)

Dortheesia citri Risso, 1813. Essai Hist. Nat. des Oranges, etc., Paris, 1813. [Not seen.]
Pseudococcus citri (Risso). Carter, W., 1942. J. econ. Ent., 35 (1), p. 14. On *Ananas comosus* (L.) (pineapple), Queensland.
Planococcus citri (Risso). Ferris, G. F., 1950. Atlas of the Scale Insects of North America, 5, p. 165. Stanford Univ. Press, Calif.

CITRUS MEALY BUG.

Host-plants:

Coleus sp., *Croton* sp., *Clerodendrum* sp., and *Erythrina* sp. growing in a hot-house at the Botanic Garden, Adelaide; *Ceratonia siliqua* L. (leaves and fruit) and on the inflorescence of *Veronica* sp., both growing in the open, Adelaide.

In this State *Planococcus citri* is a serious pest of plants grown in hot-houses and shade-houses, but has been found living in the open only once.

Pseudococcus adonidum (Linnaeus)

Dactylopius adonidum L. Maskell, W. M., 1896. Trans. Proc. N.Z. Inst., 28, p. 399. On *Acacia linifolia* at Sydney, New South Wales. This is the earliest published record of this species' occurrence in Australia, but it is likely that the specimens were misidentified because Maskell himself noted some reservations about their identity.
Pseudococcus longispinus Targioni. Halliday, O. E., 1940. J. Dep. Agric. S. Aust., 43 (12), p. 847. On *Citrus* in the River Murray settlements. This is the first published record of this species in South Australia.

LONG-TAILED MEALY BUG.

Host-plants:

In South Australia *Pseudococcus adonidum* occurs on a wide range of host-plants growing both in the open and in hot-houses.

Ps. adonidum is the mealy bug most commonly found on *Citrus* spp., pears and grape-vines in the commercial orchards of the River Murray irrigation areas, where it is a serious pest. The damage is caused by species of fungus that develop in the honey dew secreted by the insects. In navel oranges the mealy bugs aggregate at the navel end of the fruit. Oranges grown for the local market are sometimes rendered unsaleable due to an unsightly deposit on the rind caused by development of sooty mould. More serious loss may be caused by

development of a grey-green mould at the navel end of apparently clean fruit during storage and transport. The market value of Valencia oranges, which grow in bunches, is affected by development of a sooty mould on the rind where one fruit is in contact with another. In pears a grey-green mould develops when a drop of honey dew is secreted at the calyx end of the fruit, causing breakdown. The stickiness of honey dew on the surface of grapes hinders the drying process.

Ps. adonidum has been identified on the following additional hosts in the Adelaide district: *Achillea millefolium* L. (milfoil) and *Asplenium* sp.; *Cebara* sp. and *Erythrina* sp. grown in a hot-house at the Botanic Garden; *Nerium oleander* L. and *Tradescantia virginiana* L. (spiderwort) at the Waite Institute; near the core of a rotting fruit of *Cydonia oblonga* Mill. (quince); *Vitis vinifera* L. (zante currant).

***Pseudococcus malacearum* Ferris, 1950**

Pseudococcus malacearum Ferris, 1950. Atlas of the Scale Insects of North America, 5, p. 185. Stanford Univ. Press, Calif.

Host-plants:

Cucurbita pepo L. (pumpkin) at Waikerie (coll. T. O. Browning). Pumpkins which had been harvested and stored in a shed were found to be heavily infested with all stages of this mealy bug in October, 1955. This is a "long-tailed" species, the posterior wax filaments being half as long as the body. The females produce an ovisac that is loose and fluffy at first, but which becomes compact and elongated by the time all the eggs have been laid.

Passiflora edulis Sims (passion-fruit) and *Passiflora mollissima* Bailey (banana passion-fruit) at Adelaide. A heavy infestation killed the vines of both host-plants.

Tragopogon porrifolius L. (salsify) at Adelaide. Adult females were living on the roots in December, when large numbers of eggs were being laid.

The specimens from *Passiflora* and *Tragopogon* from Adelaide, together with some living on the roots of *Medicago sativa* L. (lucerne) and *Melilotus alba* Desr. (Bokhara clover) from Cardross, Victoria (coll. W. J. Webster), were identified by Dr. Harold Morrison as *Pseudococcus malacearum* Ferris, with certain reservations. He did not have for comparison the type of *Ps. malacearum*, but in his opinion these specimens appeared to be identical with presumed holotypes in the United States National Collection of Coccidae at Washington, D.C.

These specimens represent the first record of *Pseudococcus malacearum* Ferris in Australia.

***Tridiscus distichlii* (Ferris)**

Ferris, G. F., 1950. Atlas of the Scale Insects of North America, 5, p. 249. Stanford Univ. Press, Calif.

Host-plant:

Triticum vulgare Villars (wheat), Adelaide. In March and April, 1952, all stages of this mealy bug were found among the sheathing bases of the leaves of wheat which was being grown for experimental purposes in a glass-house at the Waite Institute. The eggs are laid in quick succession so that one egg adheres to the one preceding in "string of beads" fashion. An amorphous, fluffy ovisac is produced.

This is the first record of *T. distichlii* in Australia.

Family ASTEROLECANIIDAE

***Asterolecanium variolosum* (Ratzeburg, 1870)**

Coccus variolosus Ratzeburg, 1870. Tharandter Forst. Jahrb. 20, pp. 187-194. [Not seen.]

Asterolecanium variolosum (Ratz.). Russell, L. M., 1941. U.S.D.A. Misc. Publ., 424, p. 219. On *Quercus sideroxyla* at Botanic Garden, Sydney. (Specimens from W. W. Froggatt, No. 18.)

GOLDEN OAK SCALE.

Host-plants:

Quercus spp.

A. variolosum was identified on *Quercus* sp. from Mt. Lofty in 1940.

Family DACTYLOPHIDAE.

Eriococcus araucariae Maskell, 1879

Eriococcus araucariae Maskell, 1879. Trans. N.Z. Inst. 11, 218.

Eriococcus araucariae Mask. Froggatt, W. W., 1916. Agric. Gaz. N.S.W., 27 (6), p. 427.

On *Araucaria excelsa* R. Br. (Norfolk Island pine) at Sydney, and *A. araucariae* var. *minor* Maskell on *Kunzia capitata* at Sydney.

Host-plant:

E. araucariae was identified on *Araucaria cunninghamii* Aiton (hoop-pine) at the Waite Institute in 1956.

Eriococcus coccineus Cockerell, 1894

Eriococcus coccineus Cockerell, 1894. Ent. News, 5 (6), 43. [Not seen.]

Host-plant:

This species has been identified from several species of Cactaceae growing in a home-garden at Adelaide in 1952. The female scales adhere to the spines of the host.

This is the first record of *E. coccineus* from Australia.

Dactylopius indicus Green, 1908

Coccus indicus Green, 1908. Mem. Dep. Agric. Ind. ii, 2, p. 28. [Not seen.]

Dactylopius (Coccus) indicus. Anon., 1925. 1st Ann. Rep. Qd. Prickly Pear Land Commiss., 1924-25, pp. 19-28. Recorded as having given effective control of *Opuntia* spp. in Queensland during the previous four years.

Dactylopius ceylonicus Green, *indicus* Green. Anon., 1936. J. Dep. Agric. S. Aust., 40 (5), pp. 404-410. Introduction of *Dactylopius indicus* to South Australia in 1934.

Dactylopius indicus. Tough, W. A., 1938. S. Aust. Nat., 19 (1), pp. 7-9. Recorded the successful eradication of *Opuntia vulgaris* by *D. indicus* at Pooraka, South Australia.

Dactylopius ceylonicus, Dodd, A. P., 1940. The biological campaign against prickly-pear. Comm. Prickly Pear Board, Brisb. The most recent account of all aspects of the biological control of prickly-pear by cochineal insects.

PRICKLY-PEAR COCHINEAL INSECT.

Host-plants:

Opuntia spp.

Several species of *Opuntia* that have been grown as garden ornamentals or hedge plants have escaped locally from cultivation to form thickets at various places in South Australia. *Opuntia* has nowhere become naturalized other than as small, isolated patches of this kind. Cochineal insects obtained from Queensland through A. P. Dodd, Officer-in-Charge of all Investigations of the Commonwealth Prickly Pear Board, have been used by the Department of Agriculture to control these occurrences. The species principally used has been *D. indicus* Green, but a second species (near *confusus* Cockerell) has also been identified from material obtained from the same source.

A sample of mealybugs taken from *Opuntia vulgaris* Miller (= *O. monacantha* Haworth of Black (1948)) at McLaren Flat, March, 1956, was identified as *Dactylopius indicus* Green. This species was first used to control *O. vulgaris* in 1934, when a colony was obtained from Queensland (Anon., 1936, loc. cit.) and liberated upon a stand one-quarter mile long, which had originally been planted as a hedge. Within four years it had been completely killed (Tough, 1938, loc. cit.). Since that time, *D. indicus* has been distributed to other small localized escapes of *O. vulgaris*.

Dactylopius sp. (near confusus Cockerell, 1893)

Material collected on *Opuntia megacantha* Salm-Dyck from Yatina, South Australia, March, 1956 (coll. G. Young), closely resembles *D. confusus* Cockerell as defined by Ferris (1955b). The original introduction was made with material obtained from the Commonwealth Prickly Pear Board, Queensland.

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**SPECIES SUBMITTED FOR IDENTIFICATION FROM QUARANTINE
INSPECTIONS OF IMPORTED PLANTS IN SOUTH AUSTRALIA**

Family DIASPIDIDAE

- Aonidiella orientalis* (Newstead) on fruit of *Asimina triloba* DuRoi (pawpaw) from Darwin, Northern Territory, 1948.
Aspidiotus hederac (Vallot) on leaf of *Musa paradisica* L. var. *sapientum* Kuntze (banana) from Queensland.
Aspidiotus hederac (Vallot) on leaf of *Asimina triloba* from Queensland, 1950.
Chrysomphalus ficus Ashmead on fruit of *Citrus* sp. from Melville Island, Northern Territory, 1950.
Diaspis bromeliae (Kerner) on fruit of *Ananas comosus* Merr. (pineapple) from northern New South Wales, 1954.
Lepidosaphes beekii (Newman) on fruit of *Citrus limonia* Osbeck (lemon) from Queensland, 1948.
Lepidosaphes beekii (Newman) on fruit of *C. reticulata* Blanco (mandarin) from Queensland, 1948.
Lepidosaphes beekii (Newman) on fruit of *C. sinensis* Osbeck (orange) from Malta, 1953.
Lepidosaphes gloverii (Packard) on fruit of *Citrus* spp. from Darwin, 1950.
Phenacaspis sp. on leaves and fruit of *Mangifera indica* L. (mango) from Darwin, 1949.

Family COCCIDAE

- Ceroplastes rubens* Maskell on leaves of *Citrus* sp. from Victoria, 1948.
Coccus hesperidum Linn. on leaves of *Citrus* sp. from Alice Springs and Barrow Creek, Northern Territory, 1946.
Coccus hesperidum Linn. on leaves of *Ficus carica* Linn. (fig) from Alice Springs, 1948.

Family PSEUDOCOCCIDAE

- Dysmicoccus brevipes* Cockerell (= *Pseudococcus brevipes* (Cockerell)) on fruit of *Ananas comosus* Merr. from Magnetic Island, Queensland, 1954.

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GEOLOGY AND SUBSURFACE WATERS OF THE AREA EAST OF DEEP WELL, ALICE SPRINGS DISTRICT, NORTHERN TERRITORY

BY J. RADE, M.Sc.

Summary

Rocks of Archaeozoic, Proterozoic, Palaeozoic, Mesozoic, Tertiary and Quaternary ages outcrop in the area east of Deep Well, Northern Territory. Fault-folding (the term being used in Stille's sense) was favoured by the shallowness of the basement, and by the widespread occurrence of incompetent strata, which acted as semi-mobile material. Faults trending west-north-west, north and north-west are prominent. Thrust faults trending east-north-east occur in the central part of the area. The hydrogeological conditions of the area are discussed, the best rock type for the occurrence of subsurface water being Ordovician and Cambrian sandstones.

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J. RADE, M.Sc.

[Read 12 July 1956]

SUMMARY

Rocks of Archaeozoic, Proterozoic, Palaeozoic, Mesozoic, Tertiary and Quaternary ages outcrop in the area east of Deep Well, Northern Territory. Fault-folding (the term being used in Stille's sense) was favoured by the shallowness of the basement, and by the wide-spread occurrence of incompetent strata, which acted as semi-mobile material. Faults trending west-north-west, north and north-west are prominent. Thrust faults trending east-north-east occur in the central part of the area. The hydrogeological conditions of the area are discussed, the best rock type for the occurrence of subsurface water being Ordovician and Cambrian sandstones.

INTRODUCTION

This paper deals with the area east of Deep Well, which is located approximately 75 miles south-east of Alice Springs, Northern Territory. The area comprises about 2,500 square miles, and is bounded on the east by the Hale River, and on the west by the Alice Springs-Port Augusta railway line.

The country is composed in general of wide valleys separated by resistant ridges, the latter usually consisting of sandstone. The ridges in the southern part of the area are separated by wide, sandy plains where many sand dunes have accumulated, representing the disintegration products of the surrounding ridges. These plains usually provide only poor grazing country for cattle. The limestones surrounding the prominent ridges in the central and northern parts of the area are much more easily removed by erosion, forming low ridges and plains which provide good grazing land.

GEOLOGY

Formations of the following ages are encountered in the area: Pleistocene to Recent, Tertiary, Cretaceous, Ordovician, Cambrian, Upper Proterozoic and Archeozoic.

1. PLEISTOCENE TO RECENT

The deposits on the plains where the creeks have their flood-out areas, and river gravels, belong to the Quaternary Era. The sand dunes extensively developed in the vicinity of the sandstone areas and covering the plains in the southern and south-eastern parts of the area are Pleistocene and Recent.

2. TERTIARY

Lateritic products are encountered in the area, but where the country is dissected by streams the laterite has been removed by erosion. Ferruginous material, representing lateritic products, fills the dominant fractures in the Cambrian limestones 8 miles east-north-east of Deep Well, and in the Phillipson Creek area at St. Teresa Mission Station. Eight miles east of Deep Well these fractures trend N 70° W, but in the Phillipson Creek area at St. Teresa Mission Station they strike north-south.

3. CRETACEOUS

The grey shales in the eastern part of the area are of Cretaceous age. They dip at less than 5° to the south.

4. ORDOVICIAN

Madigan (1932, p. 81) observed the presence of whitish Ordovician sandstones forming the northern and southern limbs of the anticline between Deep Well and Maryvale. The present author has found that the sandstone extends further east to Pulya Pulya Creek, where it is dislocated by faults. In a ridge running east-west about 35 miles east of Deep Well the sandstone dips at 10° to the south. Apart from wormtracks, no fossils have been found in it. The sandstone is classified as Ordovician only on lithological and stratigraphical grounds, the lithology being very characteristic of Ordovician sediments in other parts of Central Australia.

5. CAMBRIAN

The Cambrian is represented by the following rock types in descending order:

Limestones, with intercalations of shales, in places intricately drag-folded as incompetent beds between competent sandstone layers.

Purple sandstones and conglomeratic sandstones forming the prominent ridges of the area. During folding these beds acted as competent layers. Most of them are strongly disturbed by faults and only scattered remnants of them are left in the area, mainly in the central part. The same sandstone occupies a larger area in the northern part of the area south of the Todd River, where it is horizontal or only slightly folded.

6. UPPER PROTEROZOIC

The Upper Proterozoic rocks consist of the following, in descending order:

Limestones and dolomitic limestones. *Collenia* was found in these 18 miles east-north-east of Deep Well.

Heavitree Quartzite, which overlies the Archeozoic rocks in the eastern part of the area at Hale River. There it is partly represented by quartzitic sandstones with gritty bands. These include purplish bands, and in appearance resemble the Cambrian sandstones. However, their quartzitic habit and their stratigraphic position — almost horizontally overlying the Archeozoic rocks with strong angular unconformity — suggest that they are of Proterozoic age. The angular unconformity between the Upper Proterozoic and the Archeozoic can be observed very well in the canyon-like river valley 78 miles east-north-east of Deep Well. Upper Proterozoic rocks partly form the tilted sides of the Archeozoic block occurring in the eastern part of the area.

7. ARCHAEOZOIC

A block of Archeozoic schists protrudes into the eastern part of the area at Hale River; the block trends south-east, and has been affected by vertical oropirogenetic movements which are discussed in the next section.

STRUCTURAL GEOLOGY

The area described belongs to the Amadeus Geosyncline. Partial regeneration of geosynclinal conditions occurred here during the Upper Proterozoic, when the Amadeus Geosyncline was filled with shallow water deposits showing distinct cycles of sedimentation.

The Taconic phase of the Caledonian orogeny terminated deposition in the geosyncline. The orogeny was there germanotype, and no igneous intrusion occurred. The author has detected fault-folding of the type described by Stille in the area. This was caused by the following factors:

1. A shallow, rigid and possibly faulted basement;
2. The occurrence of tectonically weak incompetent beds intercalated with competent beds. The incompetent beds permitted intense folding and sliding, and the competent beds favoured strong faulting.

The presence of a shallow and rigid basement underlying the central part of the area east of Deep Well is indicated by the considerably smaller thicknesses of the Cambrian purple sandstone with conglomeratic sandstone at its base than is found in the northern part of the area. It is clear that the water of the shallow Cambrian sea was more agitated in the middle part of the area, which would account for the conglomeratic character and the smaller thickness of the Cambrian purple sandstone there. The same is true for the Upper Proterozoic limestones, which in this area contain many shale as well as sandstone intercalations. This indicates the quickly changing character of the deposits, such as commonly happens in very shallow seas. From the above it can be concluded that the Cambrian sea was very shallow in the central part of the area as a result of the shallow basement. The very shallow basement explains the fault-folding which is seen particularly well in the middle part of the area. During the fault-folding the Upper Proterozoic Heavitree Quartzite, the Cambrian purple sandstone and the Ordovician sandstone acted as competent beds, with the limestones and interbedded shales which form the upper parts of the Upper Proterozoic and Cambrian deposits in the area acting as incompetent beds.

It is known that the salt deposits belonging to the Permian Zechstein played an important role in the Saxonian fault-folding in Germany, where the author has had an opportunity of investigating it closely. There the salt deposits formed a highly mobile material. It is clear that the incompetent limestones interbedded with shales have played a somewhat analogous part in the fault-folding in the Amadeus Geosyncline east of Deep Well, forming a semi-mobile material.

It may be mentioned that Hills (1946, p. 77) has already suggested the possibility of fault-folding in Stille's sense in Central Australia. The present author has proved its existence in the Amadeus Geosyncline in the area east of Deep Well.

The area mapped can be divided into three districts according to the type of folds encountered, as follows:

- (1) The western and southern portion from the Alice Springs-Port Augusta railway line to the Todd River, where folding along an east-north-east axis is found. A syncline is located north-north-east of Deep Well, and a small faulted anticline approximately 17 miles north-east of Deep Well. The main, strongly disturbed anticline which dominated this part of the area is located south-east of Deep Well. Its core is formed mainly of Upper Proterozoic and Cambrian rocks, and its northern and southern limbs of Ordovician sandstone. The Cambrian purple conglomeratic sandstone acted in the folding as competent beds, and the Cambrian and Upper Proterozoic limestones as incompetent beds. This applies especially to the Cambrian limestones where they were intricately folded, as is well seen about 20 miles east of Deep Well.
- (2) The eastern part of the area surrounding the Archaeozoic block at Hale River. The geological history of this area began with the epeirogenetic uplift of the Archaeozoic block. Because of its vertical uplift, this block has played an important role in the folding and faulting processes of the area. The folds exhibited in the eastern part of the area trend south-south-east, and therefore at right angles to the main trend of the folds in the western and southern parts of the area. The folds surrounding the Archaeozoic block at Hale River are parallel to the margins of the block, and it is clear that they were caused by the vertical uplift of the block. Similar

folding has already been described by Voisey (1939, p. 170) on the eastern margin of the Macdonnell Ranges, and according to Hills (1946, p. 76) it is characteristic of uplifted blocks in Central Australia. It may be mentioned that Condon, Johnstone and Perry (1953, p. 34), discussing the folding of the strata at Cape Range, Western Australia, consider the epeirogenetic uplift of the Australian stable block as being one possible explanation of the folding phenomena encountered at Cape Range.

- (3) *The middle of the northern part of the area*, where roughly meridionally elongated flat domes and basins are found south of Todd River. These structures are affected by faults originating in the epeirogenetic uplift of the Archaeozoic block at Hale River.

The author assumes that compressive forces in the Amadeus Geosyncline acted in a north-south direction and were not active in an east-west direction. It is clear that the flat elongated domes and basins originated because the north-south compression in the Amadeus Geosyncline was hindered by the rigid concave frame of the southern margin of the Arunta complex. The southern part of this frame was formed by the Archaeozoic block at Hale River. Such doming is a characteristic effect where folding forces encounter arcuate frames. The following can be taken as examples of such domal features in Central Australia:

- (a) The Ordovician dome of the Gosse's Range, 100 miles west of Alice Springs, on the northern margin of the Amadeus Geosyncline. In this case the rigid frame is the southern margin of the Arunta shield, which is concave against the Amadeus Geosyncline.
- (b) The basin structure at Wauchope, 78 miles south-east of Tennant Creek, discovered by Sullivan (1952, p. 15). Wauchope is situated in the Warrumunga Geosyncline; the concave, rigid, southern margin of the Sturtian Block lying to the north hindered the folding, causing the formation of basin structures.

FAULTING

Very strong faulting is exhibited in the area, which the author refers partly to the fault-folding. In the western part of the area, two sets of faults are dominant, one trending slightly north of west and the other roughly north-south. The first set is arranged partly *en echelon*.

The central part of the area is characterised by thrust-faults trending east-north-east, which are responsible for the repetition of the Cambrian sandstones and the thrusting of the Upper Proterozoic limestones over them.

The eastern part of the area is characterised by long north-west trending faults which the author believes to be closely connected with the vertical uplift of the Archaeozoic block on the eastern margin of the area. These faults call for further description. The Archaeozoic block has suffered repeated vertical uplifts; part of the evidence for this is the tilting of the Upper Proterozoic quartzites on its margins. The north west trending faults are parallel to the uplifted block, and have the greatest length and horizontal displacement of any of the faults in the area; they can be traced as far as 34 miles south-west of the block. The fault which is closest to the western margin of the Archaeozoic block on the map area and which partly separates it from the younger formations to the south-west probably trends approximately along Pulya Pulya Creek; this is inferred from the strata found to the west of the creek. The next north-west trending fault towards the south-west runs along the Todd River, and shows horizontal displacement. This fault is of considerable length, and its north-western continuation is found in the northern part of the area, where Upper Proterozoic limestones and Cambrian purple sandstones are displaced. The most

distant fault of the set lies 34 miles south-west of the Archaeozoic block and displaces the Upper Proterozoic, Cambrian and Ordovician rocks 44 miles east-north-east of Deep Well.

HYDROGEOLOGY

Three main factors govern the hydrogeological conditions in the area east of Deep Well:

- (1) Topographic relief;
- (2) Type of rock
 - (a) Its influence on the water stored along the bedding;
 - (b) Storage capacity governed by porosity and fracturing;
- (3) Geological structure.

The topographic relief plays an important part in determining the quality of the water. In mountainous areas the run-off is quick and the quality is good, but in plain country the water tends to be salty. In the mapped area in the vicinity of Todd River the water is salty; for example, that in the Bulldust bore, 50 miles north-east of Deep Well, carries 13,414 parts per million of total solids, while that in the Soakage bore, 1 mile south of Bulldust bore, contains about 18,000 parts per million of total solids.

Water with a high total solids content is found in the Cambrian limestones, where shale intercalations in the limestones form an obstacle to the free circulation of the water and favours "salting". Bores in these limestones are characterised by their sodium chloride and magnesium sulphate content.

Water in the widespread Upper Proterozoic limestones is suitable for stock; for example, the water in Twin bore, 43 miles north-east of Deep Well on the Todd River block, contains 1,934 parts per million of total solids.

The Ordovician and Cambrian sandstones are of great practical value in the area because they are characterised by large storage capacities and good quality water; the former supplies good drinking water, and the latter good stock water.

The geological structure is important in determining the yield of bores. It is significant that those bores which are located in the gaps due to faulting of the resistant Cambrian purple sandstone give a good yield; this is because the creeks flow along the shattered fault zones and replenish the water supply in the sandstones. The Phillipson Creek stock-route bore No. 1, 15 miles east-north-east of Deep Well, is an example of this type of bore; it is 122 feet deep and yielded 12,000 gallons per hour, with a total solids content of 2,972 parts per million. It is drilled in a faulted gap of Cambrian purple conglomeratic sandstone.

The bore drilled for Allambi Station, 20 miles east-south-east of Deep Well, provides an example of water with a high content of total solids; it contains 21,336 parts per million and cannot be used for stock since its total solids content is twice as great as the allowable maximum in the Northern Territory, viz., 10,000 parts per million. The bore lies on the northernmost boundary of the great plains of the Simpson Desert, and is drilled in Cambrian limestones. The quality of its water is determined by two factors, the topographic relief, and the formation of the rock.

The following analysis, kindly supplied by the Animal Industry Division, Alice Springs, Northern Territory, indicates the quality of the water found in the various formations:

RESULTS IN PARTS PER MILLION: 6250 p.p.m. = approx. 1 oz. per gallon.

	1	2	3	4
<i>Hardness (Calculated as CaCO₃)</i>				
Hardness Total	850	140	740	
Hardness Temporary	240	140	245	
Hardness Permanent	610	—	495	
<i>Free Alkali (Calculated as CaCO₃)</i>		100		
Chloride	994	2059	710	9532
Sulphate	499	1080	319	
Fluoride	1.30	1.08	2.56	2.61
Calcium	140	208	65	
Bicarbonates	415	293	299	
Sodium	520	1310	339	5150
Potassium	219	—	—	
Magnesium	122	219	165	
Silica, Iron, and Aluminium Oxides	62	32	34	
Total Dissolved Solids	2972	5202	1934	21,336
<i>Hypothetical Compounds</i> (Results in parts per million)				
Calcium Bicarbonate	553	388	264	
Magnesium Bicarbonate			120	
Calcium Sulphate	7	383		
Magnesium Sulphate	608	1015	400	
Sodium Sulphate	12			
Magnesium Chloride	56		252	
Sodium Chloride	1309	3326	859	app. 12,000
Potassium Chloride	418			
Sodium Fluoride	3	2	5	
Silica, Iron and Aluminium Oxides	62	32	34	
Total Salts	2972	5202	1934	

1. Phillipson Stock Route Bore No. 1, located 15 miles east-north-east of Deep Well, 122 feet deep, drilled in Cambrian purple sandstone. Water for analysis received on 9/2/1954.
2. Alova Bore, 55 miles north-east of Deep Well on Todd River Block. The bore is 92 ft. deep and drilled in the Cambrian sandstone. Water for analysis received on 2/12/1953.
3. Twin Bore, located 43 miles east-north-east of Deep Well on Todd River Block. The bore is 96 ft. deep and drilled in Upper Proterozoic limestones. Water for analysis received on 7/9/1953.
4. Bore, located on Allambi Station, 20 miles east-south-east of Deep Well. Water for analysis received on 26/10/1953.

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Fig. 1.—Cambrian purple sandstones in the northern portion of the area 44 miles north-east of Deep Well.



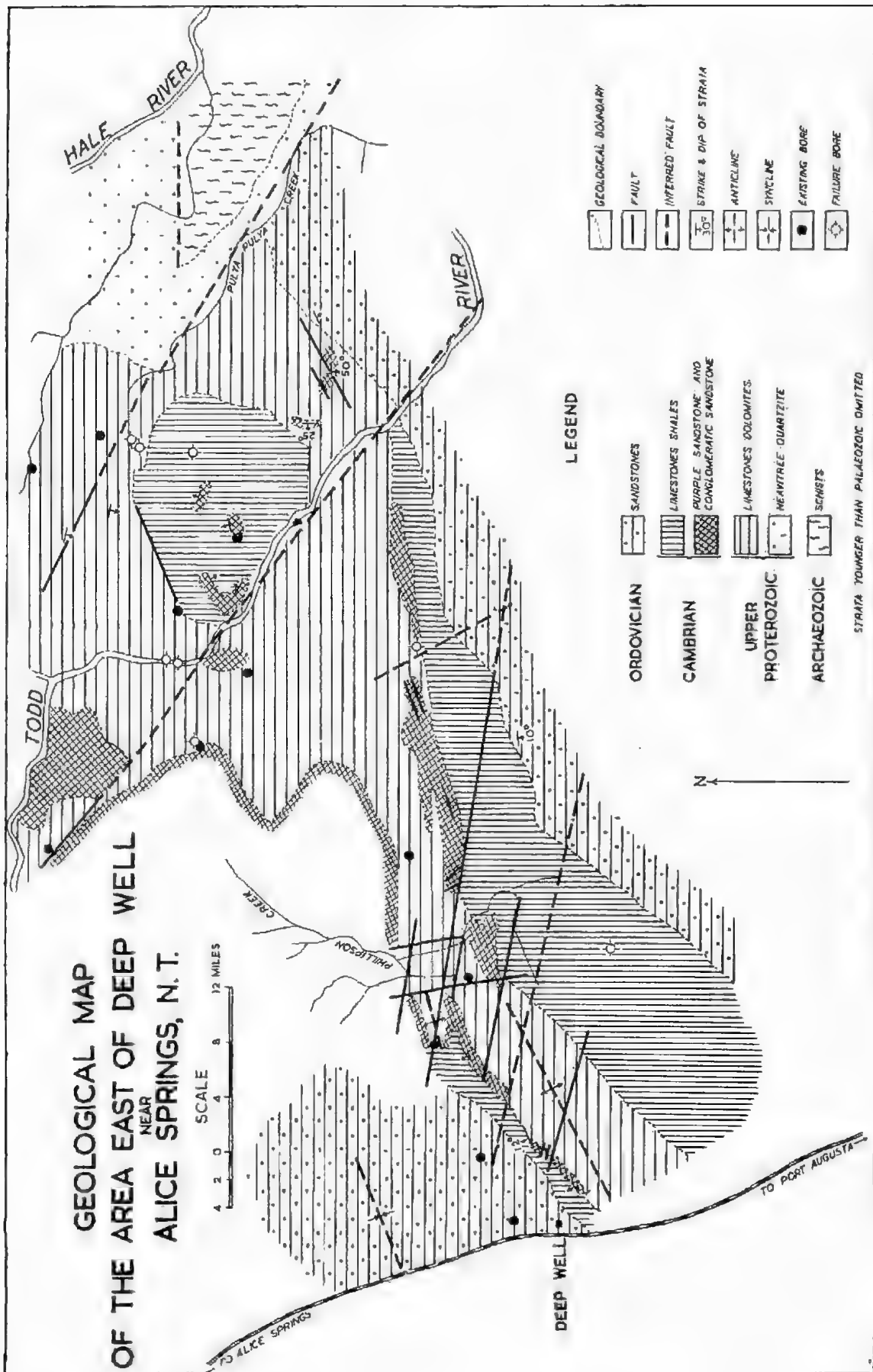
Fig. 2.—Ordovician sandstones, 36 miles ENE of Deep Well.



Fig. 3.—Upper Proterozoic limestones and Cambrian purple sandstones (in the background), 30 miles NE of Deep Well.

GEOLOGICAL MAP OF THE AREA EAST OF DEEP WELL NEAR ALICE SPRINGS, N.T.

SCALE 0 4 8 12 MILES



LEGEND

- | | | |
|-------------------|---|------------------------|
| ORDOVICIAN | SANDSTONES | GEOLOGICAL BOUNDARY |
| CAMBRIAN | LIMESTONES SHALES | FAULT |
| UPPER PROTEROZOIC | PURPLE SANDSTONE AND CONGLOMERATE SANDSTONE | INFERRED FAULT |
| ARCHAEOZOIC | LIMESTONES DOLOMITES | STRAKE & DIP OF STRATA |
| | HEAVY QUARTZITE | ANTICLINE |
| | SCHISTS | SYNCLINE |
| | | EXISTING BORE |
| | | FAILURE BORE |

STRATA YOUNGER THAN PALAEOZOIC OMITTED

MARINE FREELIVING NEMATODES FROM SOUTH AUSTRALIA

PART 1

by P. M. MAWSON*

With text figures 1-26

[Read 12 July 1956]

SUMMARY

A full account is given of *Anticoma similis* Cobb, hitherto insufficiently described; *Prooncholaimus megastoma* (Eberth) is re-described; new records and additional descriptions are given of *Polygastrophora hexabulba* (Filipjev), *Halichoanolaimus robustus* (Bastian), *H. ovalis* Ditlevsen, and *Spiliphora dolichura* de Man; new species proposed are *Metoncholaimus brevispiculum* and *Steineria pulchra*.

The marine freeliving nematodes of Australia have hardly been investigated up to the present. The only records are those by Cobb (1890, 1893, 1898) and Allgen (1929, 1951), apart from a short recent paper by the present author (1953). It is proposed to describe the local species from time to time as sufficient specimens of each become available. The majority of those described below are from inter-tidal levels, a few from material washed up by storms. All the places mentioned are in St. Vincent's Gulf, with the exception of Encounter Bay, which is on the South Coast.

Anticoma similis Cobb

Figs. 1-4

Cobb, 1898, 383, Sydney.

de Man, 1904, 13, Tierra del Fuego.

Allgen, 1930, 248, Staten Island (Tierra del Fuego).

Micoletzky, 1930, 24, Sundra Island.

Allgen, 1951, 330, Port Jackson.

In South Australia, from the Outer Harbour, on wharf piles (sublittoral), and Brighton beach, on sponges, etc., cast up by the tide after a storm.

♀ (5×) L 1.5-1.8 mm.; α 30.7-34.8; β 4.3-5.1; γ 5.9-7.5; V 42-45.5 p.c.

♂ (2×) L 1.5-1.65 mm.; α 31.7-47; β 4.7; γ 7.5-7.8.

In spite of the list of records given above, this species is not well known. The descriptions given by Cobb and by Micoletzky are unfigured and of females only; that of de Man is of a juvenile of which only the tail is drawn; Allgen describes briefly females and juveniles from Staten Island, and records without drawing or description males and females from Port Jackson in Australia (Type locality).

It was suggested by Wieser (1953, 16) that the species may be a synonym of *A. acuminata*. It is certainly very close to that species and to *A. profunda*, differing from the former in the shorter absolute length of the spicule, the longer tail (measured in anal diameters), and rather shorter cephalic setae, and from the latter in the position of the preanal organ, in the more forward position of the excretory pore and amphid, and in the slightly shorter cephalic setae (measured in cephalic diameters). These differences are all very slight, and it is probable that when further data is to hand the two species, and probably some others, may be synonymised.

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The lips are quite distinct, but labial papillae were not seen. The cephalic setae are all of nearly equal length, a little less than the head breadth. The slit-like amphids are wider in male than in female (a third and a quarter of the head breadth respectively). The cephalic setae are half a head breadth from the anterior end, and the amphid one head breadth. The row of five to six cervical setae extends for $6-10\mu$, and the most anterior is about $2.8-3$ head breadths from the anterior end; the setae are not all of the same length, the longest being 4μ .

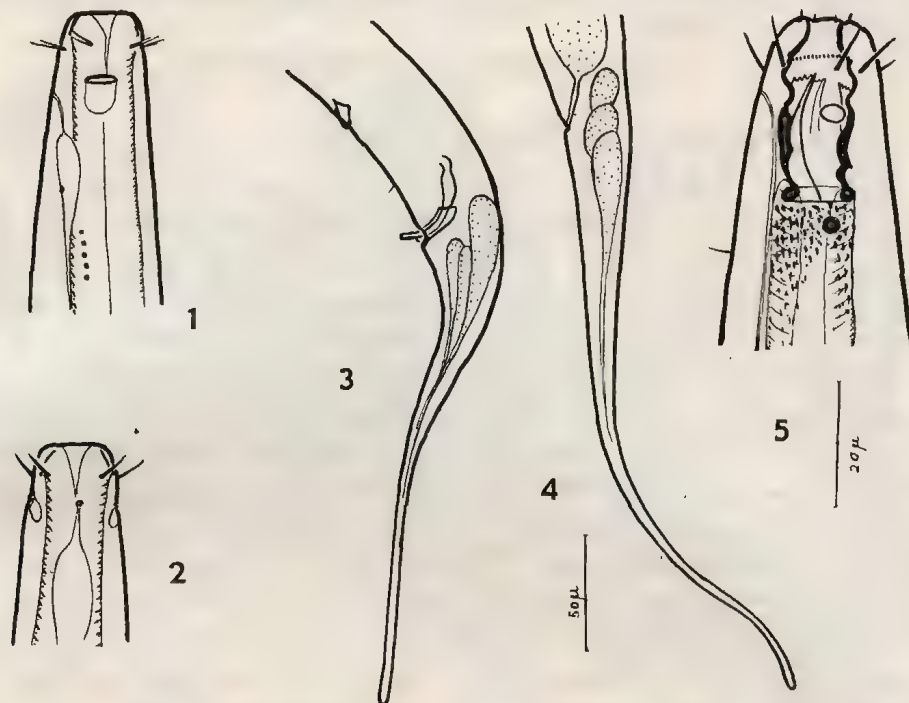


Plate 1.

Figs. 1-4.—*Anticoma similis*. 1 and 2, head, lateral and ventral views. 3, male tail. 4, female tail. Fig. 5.—*Polygastrophora hexabulba*, head. Figs. 1, 2 and 5 to same scale. Figs. 3 and 4 to same scale.

The excretory pore lies at the same level as the amphid or slightly behind it, and opens on a slight elevation of the cuticle. The ventral gland reaches to the posterior end of the oesophagus. The female tail tapers very gradually, the posterior half is cylindrical and the whole length $8.4-9$ anal breadths. The male tail tapers rapidly just behind the anus then more gradually, its whole length $6.6-6.6$ anal breadths; there is a very slight terminal swelling in both sexes. The spicules are $30-38\mu$ long (equal to the anal breadth), with narrowed proximal ends. The gubernaculum is $15-20\mu$ long; the preanal organ is 10μ long, and lies about 1.3 anal breadths in front of the anus.

Polygastrophora hexabulba (Filipjev, 1918)

Fig. 5

From wharf pile at Outer Harbour, jetty pile at Brighton, and among algae, etc., from reefs at Pt. Willunga and Pt. Noarlunga, and in algae washed up on beach at Brighton.

♀ L $3.8-6$ mm.; α $45-58$; β $5.5-7$; γ $24-28$; V $52-56$ p.c.

The species agrees in all essentials with earlier descriptions. The main

dimensions are as follows: the cephalic setae are nearly half of the cephalic diameter and the amphids a sixth of the corresponding body breadth. The labial papillae are setiform. The buccal capsule is $23\text{--}26\mu$ long, and the teeth extend to within a third of this from the mouth. The ocular pigment is formed of six longitudinal components and is most strongly developed at the anterior end of the oesophagus, near which are the lenticulate bodies.

The excretory pore is at about the same level, or anterior to, the amphids, although the "ampulla" lies more than twice the length of the buccal capsule behind the anterior end. The eggs are $160\text{--}200\mu$ by $80\text{--}90\mu$. The tail is $4\cdot2\text{--}5\cdot2$ times the anal breadth.

Prooncholaimus megastoma (Eberth)

Figs. 6-8

From wharf piles, Outer Harbour, sublittoral.

♂ (2×) L $2\cdot7$ mm.; α 27; β $5\cdot7\text{--}6\cdot3$; γ 21.

♀ (2×) L $3\cdot1\text{--}4\cdot2$ mm.; α 29-35; β $7\cdot8\text{--}7$; γ 17-21; V 74-77 p.c.

Prooncholaimus megastoma, originally described by Eberth (1863, 26) was partly re-described, without drawings, by Micoletsky from various places in the Mediterranean Sea and the Red Sea. Schuurmans Stekhoven (1943, 6; 1943, 343) proposed a new species, *P. mediterraneus*, for his own specimens from Alexandria, and placed Micoletsky's *P. megastoma* as a synonym of this, giving as the distinction from Eberth's types a greater size in the new species. A copy of Eberth's paper is not available to me. Micoletsky quotes the length of Eberth's specimen as 5-6 mm.; Schuurmans Stekhoven quotes them as 5-9 mm.

P. aransis Chitwood (1951, 626) is very close to *P. megastoma* and is separated from it by the shortness of the gubernaculum.

The proportions given by Micoletsky, Chitwood and Stekhoven are close together, and those of the South Australian specimens agree in some points with one, in some with another. The main points are given in the table below. Spicule length and anal breadth are expressed as percentages of the tail length, the width at end of the tail as percentage of anal breadth, and the gubernaculum as a fraction of the spicule length. In the South Australian specimens the proximal part of the gubernaculum is thinner than the distal part, so that it was only after close inspection that its total length was realised.

TABLE 1.

Species Authority Locality	<i>P. megastoma</i> Micoletsky			<i>P. mediterraneus</i>	<i>P. aransas</i>	<i>P. megastoma</i>
	Medit.	Naples	Suez	Stekhoven Alexandria	Chitwood Texas	Mawson South Australia
Length ♂ (♀)	2·9(3·3)	3·6(—)	2·26(—)	3·28(3·8)	2·5(2·8)	2·7(3·1-4·2)
α ♂ (♀)	25(27)			41(34·5)	24·7	27(29-35)
β ♂ (♀)	6·5(6·9)			6·55(7·6)	6·3	5·7-6·3(7·8·7)
γ ♂ (♀)	20·6(18)			23·5(19)	21(18)	21(17-21)
V	75%			75·2%	22%	74-77%
spicule length		88-100%		100%	70%	72-76%
anal br. ♂ (♀)		19-22%(—)		19%(22%)	16·5(33%)	19-20(22-25%)
br. tip tail ♂ (♀)		23-42%(—)		43·5%(27%)	—	38%(30%)
gubernaculum		1/4-1/5		1/6	1/6	1/4

Metoncholaimus brevispiculum n. sp.

Figs. 9-12

Brighton, on jetty piles among *Galleolaria caespitosa* and algae.

♂ (6×) L 2.8-3.3 mm.; α 34-48; β 5.3-6.3; γ 17-19.

♀ (7×) L 3.4-7.4 mm.; α 33-39; β 5.5-6.4; γ 17.5-19; V 66-71 p.c.

The six lips are deeply separated, each with a small labial papilla. The ten cephalic setae are short, about 1/6-1/7 of the head breadth. The amphid is between a quarter and a fifth of the corresponding body diameter, and lies

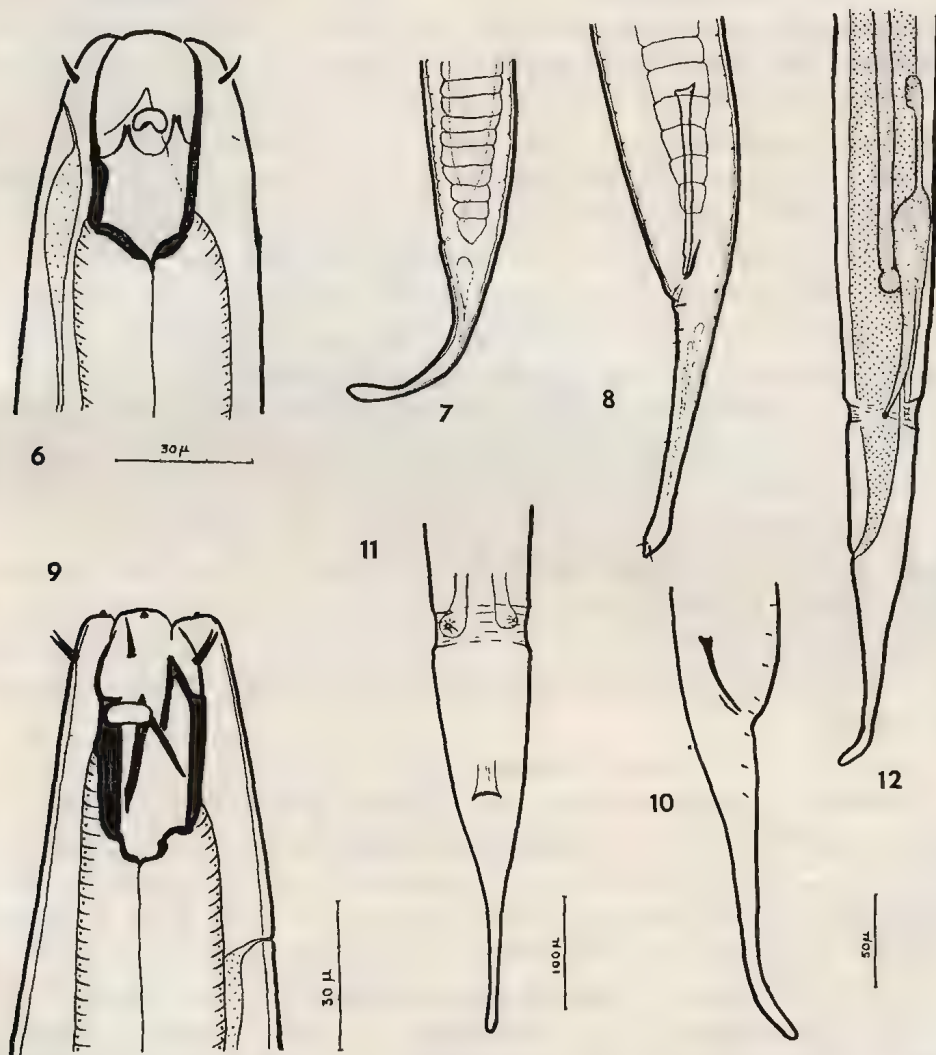


Plate 2.

Figs. 6-8.—*Prooncholaimus megastoma*. 6, head, lateral view. 7, female tail. 8, male tail. Figs. 9-12.—*Metoncholaimus brevispiculum*. 9, head, lateral view. 10, male tail. 11, female tail. 12, posterior end of female. Figs. 7, 11 and 12 to same scale; Figs. 8 and 10 to same scale.

level with the midlength of the buccal capsule. The buccal capsule, more heavily chitinated and somewhat narrower in the posterior half, is 35-40μ long and 20-25μ wide in the anterior part. The dorsal tooth and one subventral reach

just anterior to the middle, and the other subventral to about three-quarters, of the length of the buccal capsule. The excretory pore lies between 1.5-2 times the length of the buccal capsule from the anterior end.

The unshelled eggs are $110 \times 50\mu$, the shelled ones $120-150\mu \times 60-70\mu$. The two external openings of the demanian system are somewhat dorsal, $130-140\mu$ in front of the anus, in which region the body is distinctly constricted; the uvette (or rosette organ) about twice this distance from the anus, is an ampulla, as figured by Cobb (1930) for *Oncholaimium appendiculatum*, and simpler than that of *Metoncholaimus pristiurus*; the osmosium is about 400μ from the anus. Cobb (*loc. cit.*) observed that a demanian system is apparently less prevalent among Oncholaims living in thoroughly oxygenated water; this species is an exception to this, as the worms occurred on the part of the piles exposed only at low spring tides and below this, in clear unpolluted water on a sandy bottom.

The tail of the female is about 4.2-5 times the anal breadth, tapering in the proximal half, cylindrical in the distal, with a slightly enlarged tip. The male tail is 4.4-5 times the anal breadth; the body narrows sharply at the anus, the proximal third of the tail is tapering, and the rest cylindrical with slightly swollen tip as in the female. There is a slight papilliform thickening of the cuticle of the anterior lip of the anus, associated with some subcuticular development, but without setae. The two rows of small submedian setae, 5 preanal and 3 postanal, are not seen except under high power. The spicules are $40-45\mu$ long; only a little more than the anal breadth. They are straight and tapering. A small gubernaculum 12μ long is seen in some specimens.

This new species is the Enoploid found in the greatest numbers on the Brighton jetty piles. Only females with eggs in the uterus (not necessarily shelled), but males of varying development, were measured. The species is assigned to the genus *Metoncholaimus* because of the presence of a single ovary associated with a complex demanian system, and the type of tooth arrangement, one subventral and the dorsal being equal in length and shorter than the other ventral. The spicules, however, are shorter than in other species, reaching only a quarter of the tail length. In this character and in the form of the demanian system, the species resembles those of the genus *Oncholaimium*, from which, however, it is sharply differentiated by the absence of a mid-ventral caudal papillae in the male. It is distinguished from other *Metoncholaimus* spp. by the shortness of the spicules.

Genus STEINERIA Micoletsky, 1921

Micoletsky proposed *Steineria* as a subgenus of *Monhystera* to include *M. polychaeta* Steiner 1915, *M. pilosa* Cobb 1914, and *M. horrida* Steiner 1915. His diagnosis of the genus is brief, little more distinction being made than that there are very numerous setae (36-40) at the anterior end. No species is selected as the type of the subgenus, the three being quoted in the order given above. Stekhoven and Coninck in 1933 elevated *Steineria* to the level of a genus, and added *S. setosissima* (Cobb), syn. *Monhystera setosissima* Cobb 1893, and a new species, *S. mirabilis*. They stated that *Steineria* is "characterised" by its distinct 8-fold symmetry in the distribution of labial and cephalic setae, and therefore exclude *Monhystera horrida* Steiner as it possesses a 6-fold symmetry. They also stated that *Steineria setosissima* becomes the type species of the genus, presumably as it was described earlier than any of the others ascribed to the genus. The validity of this is, however, doubtful, as the species was not mentioned by Micoletsky in his account of *Steineria*. More recently, Gerlach (1951) re-described *S. mirabilis*, from fresh material and finds that the labial and cephalic setae are a symmetry of six while those further back, nuchal setae, are in one of eight. Gerlach added at the same time a new species, *S. polychaetoides*, and in 1955 (pp. 294, 296), two more new species, *S. paramirabilis* and *S. punctata*, and in all of these a similar condition is present.

In descriptions of all the species, if labial papillae are mentioned, there are six, setiform or papilliform. In most descriptions the cephalic and nuchal setae are collectively referred to as cephalic setae, and usually as occurring in a symmetry of eight. However, in the figures given of *S. pilosa* and *S. polychaeta* there is a ring of setae which are anterior to or on a level with the anterior most nuchal setae, or which are out of line, in a longitudinal sense, with these, one set being distinctly lateral instead of sublateral; it seems at least possible that these are the true cephalic setae and that they are in six groups. These species would then agree with *S. horrida*, *S. mirabilis*, *S. polychaetoides*, *S. paramirabilis*, *S. punctata*, and *S. pulchra* n. sp.*

S. polychaeta was the first in the list given by Micoletsky of species belonging to his subgenus, and so might strictly be regarded as being the type species. No figure is given by Cobb of *S. setosissima*, and the description of the setae at the anterior end is ambiguous.

B. G. Chitwood (1950, 65, fig. 60, 11, JJ) describes *Steineria* as having an internal circle of 6 papillae and an external circle of 10 or 12 setae according to the species, as well as numerous somatic setae grouped anteriorly in eight longitudinal rows, 4 submedian and 4 sublateral. Chitwood's original drawings are of "*Steineria* sp.", locality not given.

Gerlach (1955) describes additional cephalic setae in the male (as in the new species described below), and his figures show these arranged somewhat as in Chitwood's figure of *Steineria* sp.

A key to the species so far allotted to the genus is given. In it the question of symmetry is ignored, distinctions being made on other characters. For convenience the labial sense organs are referred to as lso, the nuchal setae as ns, the body setae as bs, cephalic setae as cs, and cephalic diameter as cd.

- | | |
|--|--------------------------|
| 1. Setae other than ns, absent on body..... | 2 |
| Body setae present..... | 3 |
| 2. Length cs less than half cd; lso papilliform..... | <i>S. horrida</i> |
| Length cs nearly equal to cd; lso setiform..... | <i>S. pulchra</i> |
| 3. Length bs more than 4 × body width..... | <i>S. mirabilis</i> |
| Length bs less than 2 × body width..... | 4 |
| 4. Centre of amphid about 2 × cd from anterior end..... | 5 |
| Centre of amphid 1.5 × cd or less from anterior end..... | 6 |
| 5. β 6.2; spic. 56μ long; gub. 2/3 spic. L..... | <i>S. setosissima</i> |
| β 3.9-4.3; spic. 23-24μ; gub. about ½ spic. L..... | <i>S. paramirabilis</i> |
| 6. Longest ns 2.5-3 × cd; lso setiform..... | <i>S. pilosa</i> |
| Longest ns 1.5-2 × cd; lso papilliform..... | 6 |
| 7. Cuticle with transverse rows of punctations..... | <i>S. punctata</i> |
| Cuticle finely striated..... | 8 |
| 8. Amphids 1/2-3 of cd..... | <i>S. polychaeta</i> |
| Amphids ¼ cd..... | <i>S. polychaetoides</i> |

Steineria pulchra n. sp.

Figs. 13-16

From weeds on a jetty pile, Outer Harbour, and among holdfasts of *Hormosira* sp. and *Ulva* sp., Encounter Bay.

♂ (2×) L 1.9 mm.; a 19, 24; β 5.1, 4.2; γ 6.6, 8.2.

♀ (2×) L 1.5, 2.17 mm.; a 23, 31; β 3.8, 4.3; γ 6.2, 7.4; V 66 p.c., 67 p.c.

J (3×) L 0.85-1.85 mm.; a 28.3; β 6.3-6.8; γ 4.15-4.6 (?).

* When this paper was read the author had not seen the description of *S. parapolychaeta* Gerlach 1953, nor a discussion of the genus *Steineria* by Wieser 1953, 74, in which two new species *S. cobbi* and *S. pectinata* are added; Wieser considers the genus should be redefined and excludes *S. horrida* and *S. mirabilis*. Wieser also, erroneously, quotes *S. setosissima* as the type.

The cuticle is ringed, without setae except near head, at tip of tail and on male tail. The head bears six lips each with a 4μ long setiform papilla, and six pairs of cephalic setae, the longer of each pair 20μ , the shorter about $2/3$ this length. Behind this are nuchal setae arranged in eight longitudinal rows, in sublateral and submedian positions. In each of these rows the three (submedian) or four (sublateral) setae are long and stout, and increase in length from before backwards, the anterior ones being about $50-60\mu$, the posterior $75-80\mu$. Behind these in each row are two more shorter setae separated from them by a short distance in the sub-median rows and a rather longer space in the sublateral. In the two male specimens there is also a short, slender seta in each row in front of the stout setae. Submedian and sublateral setae are of similar lengths in corresponding positions.

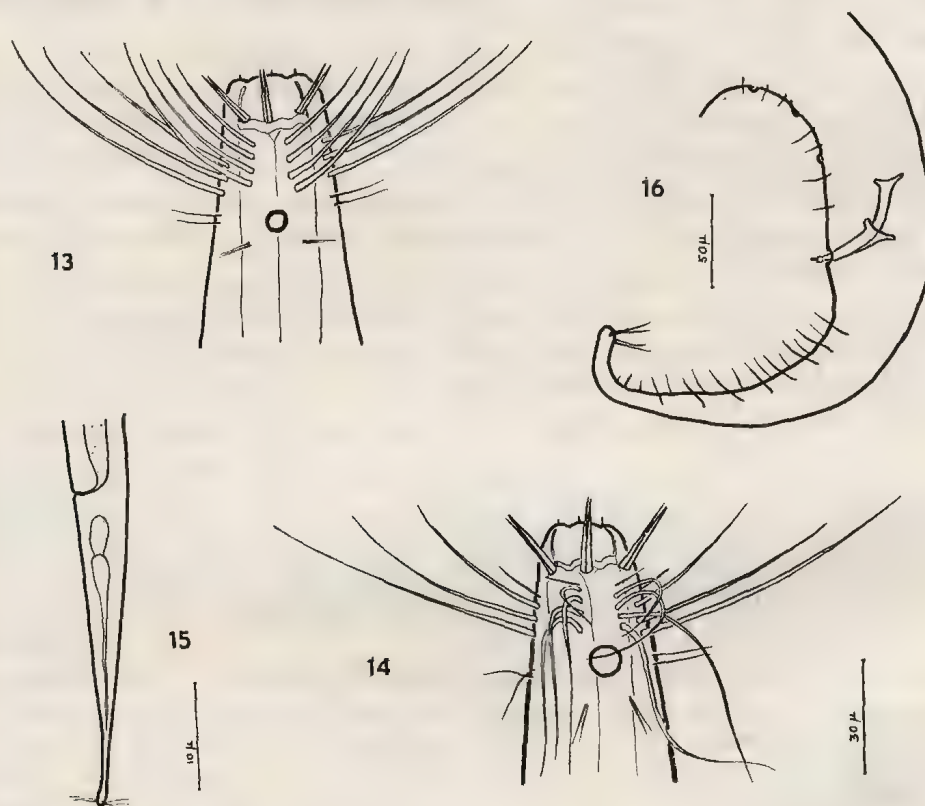


Plate 3.

Figs. 13-16.—*Steineria pulchra*. 13 and 14, lateral views of heads of female and male respectively. 15, female tail. 16, male tail. Figs. 13 and 14 to same scale.

The buccal capsule is wide and unarmed, with a narrow undulating cuticularised ring around its base. The circular amphid is $9-10\mu$ in diameter in the male, 7μ in the female, these being a quarter and a fifth of the corresponding head width respectively. It lies just behind the longest nuchal setae, except in one male in which it is a little more anterior.

The nerve rings surrounds the oesophagus at a third of its length from the anterior end. The excretory pore was not seen.

The tail tapers in the anterior $2/3$, the distal third is cylindrical with a swollen tip bearing two pairs of strong setae. The tail is $4.6-5.2 \times$ the anal breadth in the male, $5.8-6 \times$ in the female. The male tail bears on the sub-ventral surface numerous long, slender hairs. In front of the anus are three

median papilliform preanal organs, between them several slender setae. The stoutly built spicules are 60μ long, with expanded proximal ends; the gubernacular pieces are rather more than half this length, and are of similar shape. This form of the gubernacula differs from that described for most other *Steineria* spp., as there is no backward prolongation.

The species is closest to *S. horrida*, from which it differs in several small features. As *S. horrida* is known from females only, a complete comparison is not possible. The South Australian specimens are now considered as representing a new species. The collection of more material of both species may widen the diagnosis of each and bridge the gap between them.

Spiliphera dolichura de Man, 1893

Figs. 17-21

From Port Willunga among coralline algae (lower littoral) and Brighton among algae washed up after storm.

♂ (4×) L 1.4-1.7 mm.; α 26.6-35; β 7.8-2; γ 2.7-3.6 (?).

♀ (5×) L 0.85-1.9 mm.; α 28.3-33.3; β 6.5-8.5; γ 3.4-4.6 (?); V 39.4-53 p.c.

These specimens are small, stout worms with a long filiform tail. The cuticle bears coarse punctations; slender setae are borne in submedian positions throughout the body length, and are more numerous, and longer, in the oesophageal region and on the male tail. Labial papillae were not observed. The six setae in the first cephalic ring are about 3μ long, the four submedian setae just behind these are 30μ long. Just behind the amphids are four pairs of slightly shorter setae (25μ) in submedian positions, the most anterior of the body setae. The amphids are transversely oval, in $1\frac{1}{2}$ turns.

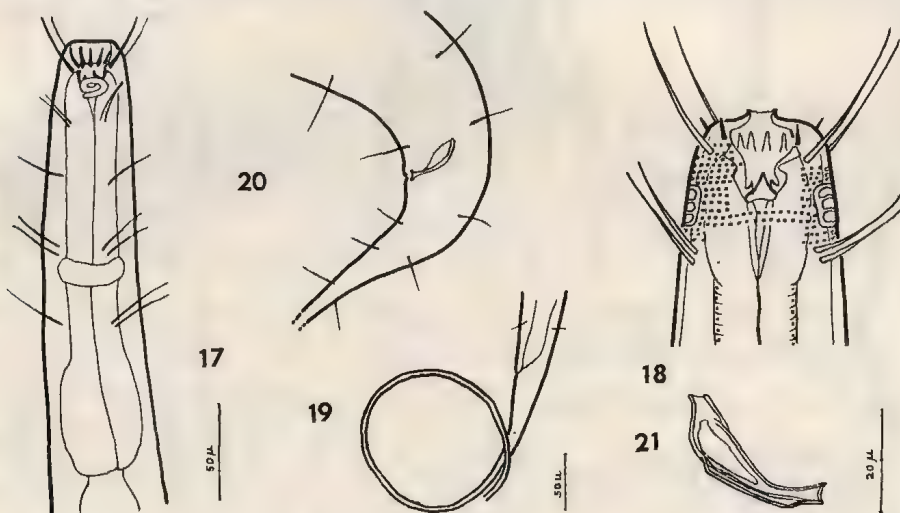


Plate 4.

Figs. 17-21.—*Spiliphera dolichura*. 17, oesophageal region. 18, head, dorsal view. 19, female tail. 20, male tail. 21, spicule. Figs. 17 and 20 to same scale; Figs. 18 and 21 to same scale.

The anterior cup-shaped part of the buccal capsule is 12μ in diameter, 7μ deep, and is followed by a strongly chitinised more or less funnel-shaped part embedded in the anterior end of the oesophagus, and with one large dorsal and two shorter lateral, teeth at its base. The anterior slightly wider part of the oesophagus in which the structure is more homogenous, has a strong cuticular lining.

The anal breadth of the male is 40-45 μ , the spicule length 30-35 μ . Close examination of these males, in which the spicules are very clear does not bear out de Man's interpretation of the shape of the spicular apparatus. What he called the gubernaculum, a lateral flange ending distally in an enlarged half funnel, appears to be a part of the spicule itself. It was not possible, however, to get a ventral view of the apparatus.

The females contained but a single egg, the largest of these was 60 \times 26 μ .

The measurements and morphology of these South Australian specimens are comparable with those described by de Man; the greatest difference is in the greater length of the first paired post-amphidial setae; this is the main difference also between them and those recorded by Wieser from the coast of Chile (Wieser 1954, 117). The species is widespread, having been recorded from the North Sea (de Man 1893, 94); the Mediterranean (de Rouville 1903, ?; Allgen 1942, 48); Pacific coast of Chile (Wieser 1954, 117); Tierra del Fuego (Allgen 1930, 29), Campbell Is. (Allgen 1932, 126), Kerguelen Is. (private record, unpublished), South Australia (above).

Halichoanolaimus robustus (Bastian)

Figs. 22-23

From wharf piles, Outer Harbour, among weeds, etc. Sublittoral.

♀ (6 \times) L 2.2-3.3 mm.; α 25-30; β 5-7.7; γ 17-30 (?); V (5 \times) 44-52 p.c.; (1 \times) 63 p.c.

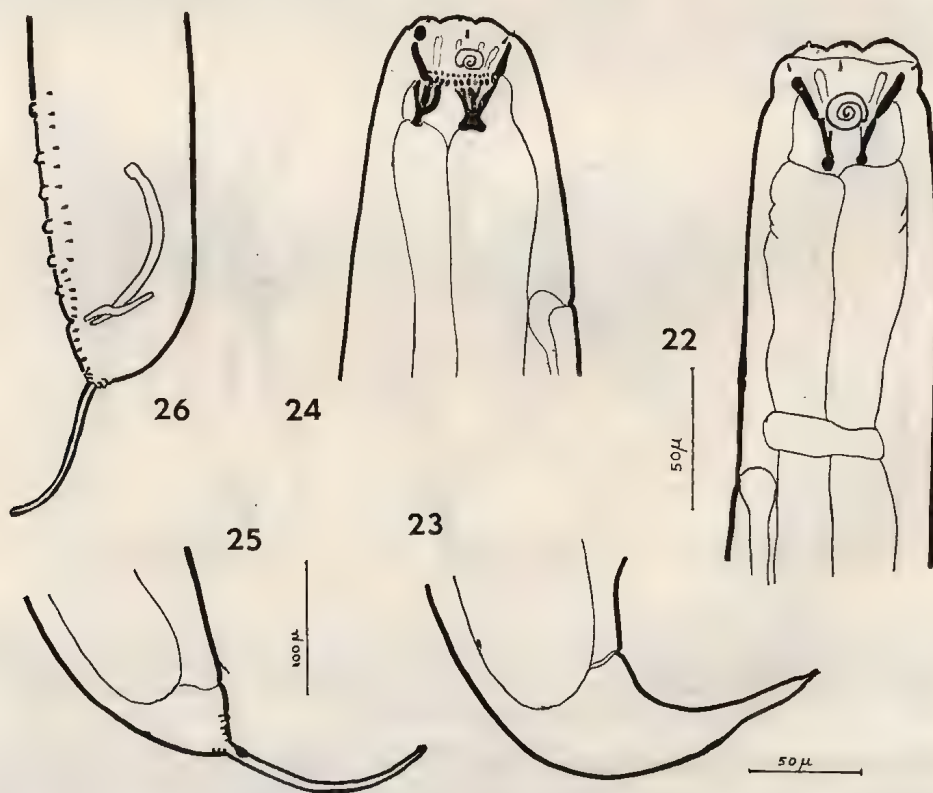


Plate 5.

Figs. 22-23.—*Halichoanolaimus robustus*. 22, anterior end, lateral view. 23, female tail. Figs. 24-26.—*H. ovalis*. 24, head, lateral view. 25, female tail. 26, male tail.

Figs. 24, 25 and 26 to same scale.

Six female worms are referred to this cosmopolitan species; the measurements and appearance correspond with those assigned to the species by other authors. There is also a close resemblance to *H. hinemoae* Ditlevsen 1930 from New Zealand, and it is possible that this species is a synonym of *H. robustus*.

The exact position of the anus is in doubt in many of the specimens. The oesophagus and anterior part of the intestine are heavily pigmented. The habit of the worms is to lie in one or two coils, so they are readily picked out, living or in pickle, by their appearance. This pigment was mentioned by Bastian.

Halichoanolaimus ovalis Ditlevsen, 1921

Figs. 24-26

From limestone reef near Edithburg, in sand pockets among *Zostera* sp.

♂ (7×) L 3.35-4.2 mm.; α 21.2-28; β 6.3-7; γ 20-28.

♀ (2×) L 3.6-4.35 mm.; α 24-24.1; β 6.7-6.8; γ 18-25.6; V 51-52.

Ditlevsen 1921, 8 (Auckland Island):

(2×) L 1.8 mm.; α 18; β 7.5; γ ?.

Allgen 1928, 271 (Campbell Island):

(2×) L 1.3 mm.; α 17.3; β 5.2; γ 7.2.

It will be seen from the measurements given above that the South Australian specimens assigned to *Halichoanolaimus ovalis* are larger than those from the Auckland and Campbell Islands. They also differ in having fewer spirals in the amphid, and the absence of any great degree of pigmentation in the alimentary canal. The male differs from that described by Allgen in the shape of the tail and γ value. In spite of these points, the similarity in shape and proportions between these and those described by Ditlevsen is so great that they are referred to the same species.

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A DATED TARTANGAN IMPLEMENT SITE FROM CAPE MARTIN, SOUTH-EAST OF SOUTH AUSTRALIA

BY NORMAN B. TINDALE

Summary

This paper records the finding, at Cape Martin, South Australia, of an aboriginal campsite of the Tartangan Culture which has been dated, by a Carbon 14 test at the Dominion Physical Laboratory, Lower Hutt, New Zealand, as having been occupied in 8700 ± 120 B.P.

Evidence is produced suggesting that the *terra rossa* soils in which this, and some other Tartangan relics on the Woakwine Range at Section 8 Hundred of Symon were found, were already in existence prior to this date and therefore before the period of the Mid-Recent High (10 ft. Terrace). The theory that they were only formed at the later date and thus were evidence for a "Great Arid Period" at that time (Crocker and Wood, 1947) is discounted. Instead, the evidence may tend to support another view, first put forward by Tindale (1947) which suggests that these soils were developed more particularly during periods of high rainfall, as residuals, following the solution of the surface layers of the lime sands originally forming the surface layers of the dunes on which they are still perched.

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INTRODUCTION

During a holiday visit to the south-east of South Australia and to Western Victoria, in December 1946, and January 1947, archaeological sites of the aborigines were examined between Cape Bridgewater and Kingston. Cape Martin, one of the sites, provided data which, after study again in November 1955 and upon comparison with information from other sites, has resulted in the following paper. The first mention of the site and of the carbon 14 date associated with it, is by Tindale (1956) in the Report of the South Australian Museum, 1955-1956.

On the first visit the author was accompanied by Mrs. D. M. Tindale. On the second occasion Mr. H. Burrows of the South Australian Museum furnished much appreciated help in searching for implements, and I am indebted further to him for assistance in the preparation of some of the diagrams illustrating this paper.

During the earlier visit a site at Cape Northumberland was examined. This also is referred to in the paper. Cape Northumberland was visited a second time in company with a larger group of anthropologists, including E. C. Black, T. D. Campbell, D. Casey, J. B. Cleland, P. Hossfeld, R. Keble, S. R. Mitchell, and G. Walsh, who attended working conferences at Millicent in February 1947 and February 1948. On the 1947 occasion, a site at Section 8, Hundred of Symon, was examined; this site also proved of significance in the development of the history of the Cape Martin site. It also is particularly mentioned in this paper.

Indirectly and directly I am indebted to my many colleagues for the stimulus which comes from discussion and comparisons of data. However, the observations recorded herein are ones made by myself and any errors or misinterpretations of the evidence are my responsibility.

* Curator of Anthropology, South Australian Museum, Adelaide.

THE CAPE MARTIN SITE

Cape Martin is a narrow-necked peninsula standing out to sea in a southerly direction at the western end of Rivoli Bay, and forming an outlying eastern portion of the Hundred of Rivoli Bay. The headland is just to the south of Beachport (140° 01' East Longitude × 37° 31' South Latitude). This is a fishing village and summer holiday resort. Text figure 1 gives a sketch map of the area.

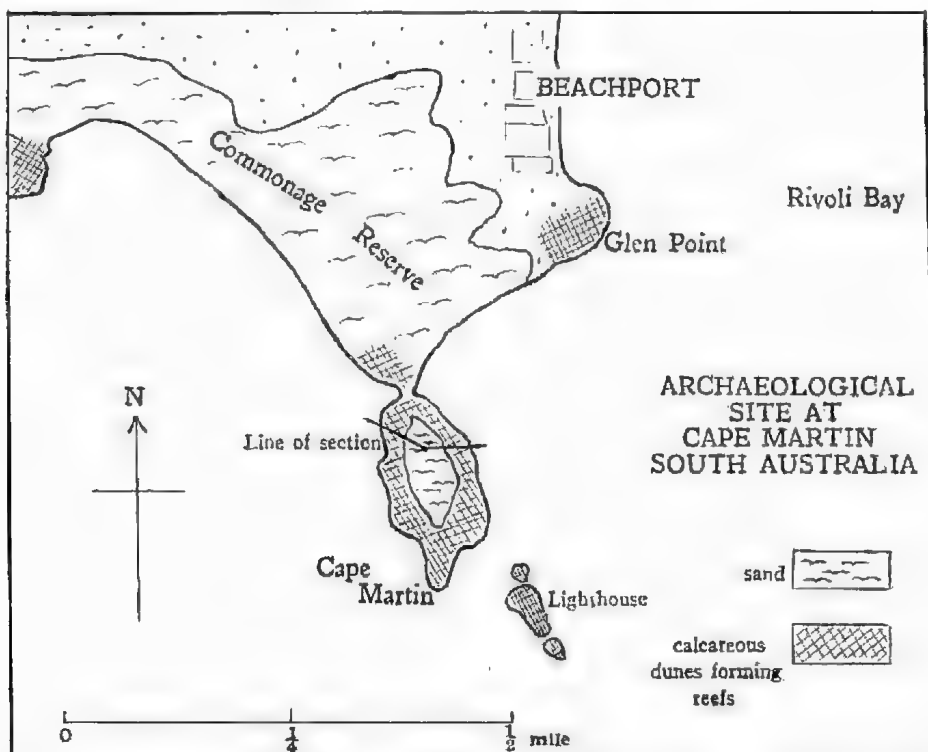


Fig. 1.—Sketch map of the vicinity of Cape Martin, South-East of South Australia.

Cape Martin headland and a number of outlying islets and reefs are parts of a platform of consolidated wind-blown lime sand of very Early Recent or possibly Late Pleistocene Age. It is what is left of a line of earlier coastal dunes which once stretched along the shore line. These residuals resisted the sea when it broached the dunes to form Rivoli Bay. According to some views there may be a core of still older dune rock within these dunes which at one time may then have been part of a group of small islands and reefs off the Pleistocene coast line during a late interglacial phase. Underlying all to the south is Tertiary limestone. Perched on these foundations is a mass of much newer and in large part unconsolidated white lime sand of Late Recent Age (Post 10 ft. Terrace) which in places reaches a height of sixty feet. This sand covers the soft lime rock of the earlier dune series. When doing so it scaled down also an old red soil horizon which is found at various heights from about twenty feet above sea level down to several feet below present sea level. The red soil follows the contours of the older dunes and is thicker in the swales than it is on their heights. On the highest parts of the peninsula there is evidence that this soil cover, a *terra rossa*, had in part been stripped before being covered by the Newer Lime Sands. Text figure 2 is a section of Cape Martin Peninsula at the site

about to be described. It is in part diagrammatic and is in two portions, the western section being drawn in a N.W.-S.E. direction and the balance in an E.-W. direction. The cliff which bounds the peninsula on three sides is being attacked very vigorously by the stormy waters of the Southern Ocean. Huge sections of it are being undermined by the sea and destroyed. Text figure 2 was drawn as the section appeared in 1947. By 1955 some 25 feet of the cliff edge on the ocean side had foundered and is now present only as large blocks, of some six to fifteen feet in diameter, which have slumped into the sea. In a few more years time the whole site may well be destroyed. The root of Cape Martin Peninsula has been breached in recent storms and at high tide a few seas now cross right over into the Bay, so that in a matter of years the peninsula will become an island.

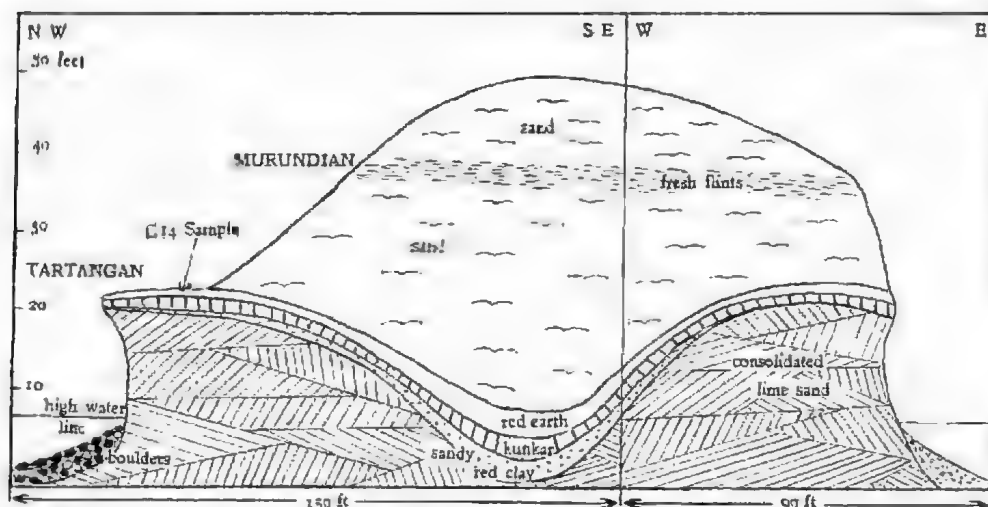


Fig. 2.—Section across Cape Martin Peninsula; ocean side to the left, showing earlier and later occupational horizons.

When the site was first noticed a discoidal flint implement was found in the B horizon of the *terra rossa* firmly imbedded in kunkar lime. Other examples were found in the A horizon of this soil.

Stratigraphically from twenty to thirty feet above the camp site in the *terra rossa* soil, was found a later aboriginal occupational horizon with fresh-looking flint implements, indicating a separate and seemingly much later period of human occupation at Cape Martin.

At this point it is as well to indicate that in the original field notes the several beds to be discussed herein were labelled as A, B and C, the oldest being called A. In this paper standard terminology of the Soils Division is adopted in describing the situations of the finds.

On physiographic grounds it was deduced that the earlier land surface indicated by the *terra rossa* must have been in existence since at least Early Recent times and that the site must have been occupied prior to 10 ft. Terrace time (Mid-Holocene Thermal Maximum) at a period when the foreshore at the nearest point was of a sandy nature, since the predominating shell of the food shell assemblage in the camp was a species of *Chione*, with some *Mytilus* shells indicating also the presence of sheltered and somewhat muddy, brackish water. The shell fauna of the more recent site above was made up predominantly of rock shells, of which *Turbo undulatus* was by far the most common, as it is today among the rocks of the present cliffs. This fauna was considered

to be Post — 10 ft. Terrace in age, since it was in a shell sand still actively being deposited at the present day.

More detailed work was possible on the second visit and it was then possible to demonstrate that a few *Turbo* shells were present also among the charcoal and ash material of the hearth in the *terra rossa* from which the sample of carbon was taken for C14 analysis. Thus the people did have access to rocky shores, although the general picture of a change in local availability of types of shell food was confirmed.

A possible source for the quiet and muddy water faunal remains was indicated by a thin bed of black mud with a brackish-water suite of shells which a little to the north of the section, appears just at present low tide mark. This extends through the base of the peninsula from the ocean beach coast to the bay and underlies the slightly consolidated basal layers of the Newer Dune Sands.

SITE AT SECTION 8, HUNDRED OF SYMON

The Woakwine Range is a line of consolidated limestone considered to be of Late Pleistocene Age (Tindale, 1947; Hossfeld, 1950; and Sprigg 1952) and to represent the dunes of the shoreline of the 25 ft. Terrace. On its crest and in swales between ridges on the wide undulating top of the crest of the dune belt, which locally is up to a mile or more in width, are red sandy soils of *terra rossa* type. In places present day erosion has exposed limy pillars of a B horizon in this soil. This stripping is seemingly being brought about by clearing of the cover of vegetation, by overstocking with sheep in times of drought, and by depredations of introduced rabbits. The sandy reddish soil appears largely to be the residues from the leaching away of the upper layers of shell lime sand during the copious winter rains. It contains also the quartz sand residues, which in part at least seem to be the silica derived from the mechanical abrasion of the flint boulders of the Tertiary Marine Beds on the seashore immediately in front of the Woakwine Range.

The 'blow-outs' exposing the lower layers of the soil and aboriginal camping sites extend into Sections 10A and 10B in the same Hundred. Campbell, Cleland and Hossfeld (1946) have given a map which shows the general area of these sites on the crest of the Woakwine Range. At some places in the district microlith implements of types we have elsewhere established to be associated with the Mudukian culture have been found on the surface and which, by data established elsewhere, are indicated to belong to a period several thousand years later in time. The main site at Section 8, which is of particular interest to us for the present purpose, lacks the microlith suite of implements. Instead, the only implements present are flint ones, stained a bright orange red, and of the same types as are present in the lower stratum at Cape Martin. Erosion has revealed these implement flakes in some profusion on the stripped surface while other specimens are still *in situ* in the sandy red earth.

CAPE NORTHUMBERLAND SITE

A site at Cape Northumberland had been visited by D. M. Tindale and myself a few days before the discovery of the Cape Martin site. Existence of this site had been reported to me some years previously by Mr. H. L. Sheard. Knowledge of its stratigraphy was of considerable help in the preliminaries of understanding the Cape Martin site. At Cape Northumberland the older land surface seemingly had been entirely stripped of an upper soil horizon at some phase of its history. Implements were found lying on the eroded surface of the very indurated kunkar horizon. They appeared to be ones which had been exposed before being buried again under the Newer Lime Sands now perched on the top of the cliff. Figure 3 gives a sketch section, from west to east, at a large occupation mound of the aborigines immediately north of the Point on

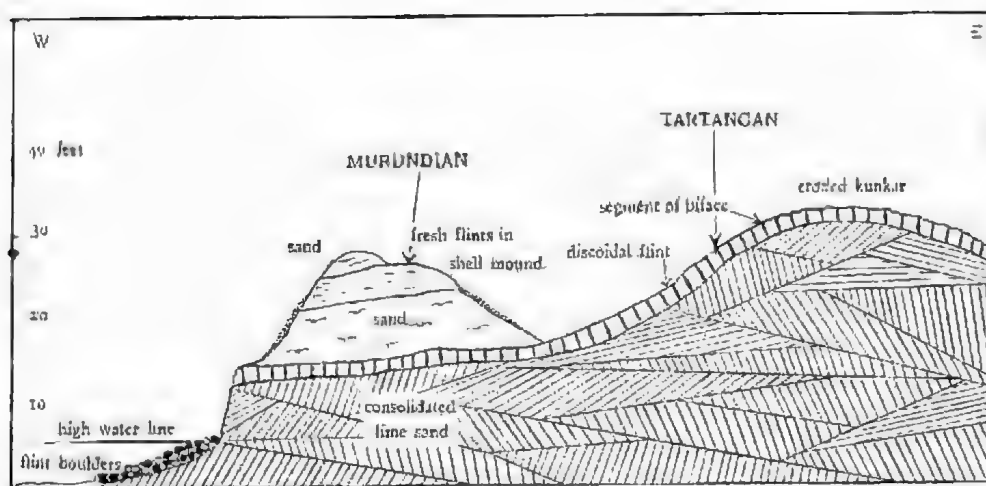


Fig. 3.—Sketch section of Cape Northumberland showing earlier and later implement horizons at Section D, Hundred of MacDonnell.

Section D, Hundred of MacDonnell. This mound, of about one-half an acre in extent, is situated immediately above the only practicable present day path of access from the northern beach to the cliff top. This shell mound had formed as a result of aborigines living there not so long ago. The presence of the capping of shells had delayed the stripping away of this upper sand in Post European times. Thus it still forms a definite mound of the type known in Victoria as 'myrniong', perhaps more correctly called ['marniong']. On parts of this mound some of the sand set in motion in Post European times is perched. Flint implements of the mound surface are freshly worked and even those of the blue-black flint from the underlying Tertiary beds, which are very liable to bleaching, have retained all or most of their original colour. The shells of the campsite are predominantly those of the rocky footings of the present cliff, with *Turbo undulatus* as the most common species. The implements of the mound typologically are the same as those of the upper site at Cape Martin, and are identified as of the culture phase we call Murundian. The kunkar horizon yielded, loose on its surface, older kinds of implements such as are in the *terra rossa* soil at Cape Martin, and comparable with Tartangan ones.

IMPLEMENTS OF THE RED SOIL AT CAPE MARTIN

At Cape Martin the first implement discovered in the red soil layer was a discoidal flake struck off on the long axis, 6·8 cm. in length, 4·5 cm. in width and 1·7 cm. in general thickness. The material from which it had been manufactured probably was blue-black flint, such as is derived from marine sediments of Tertiary Age. The Cambier Limestone, which contains this flint as angular masses, underlies portions of the area to the south as boulders on a planed-off marine platform. Upon it the Pleistocene and Recent dune limestones and shallow estuarine muds have been deposited.

This implement, now specimen A.39664 in the collections of the South Australian Museum, was included in the highly calcareous B horizon of the soil, with a small portion projecting from the lime layer. Only after considerable development *in situ* was it determined to be an implement. It had been bleached white, and so much of the original silica had been removed by chemical alteration, that it could be said to be merely a "ghost" in chalky lime of a flint

implement. Figure 4 shows three views of it. A portion of the cutting edge was injured in removing it from the kunkar. The implement was buried when fresh as is evident from the sharp cutting edge persisting on that part which remains intact. The prepared striking platform is at an angle of about 110 deg. to the flake face of the implement. The removal by the maker of primary, secondary and tertiary flakes had produced an evenly rounded profile on the

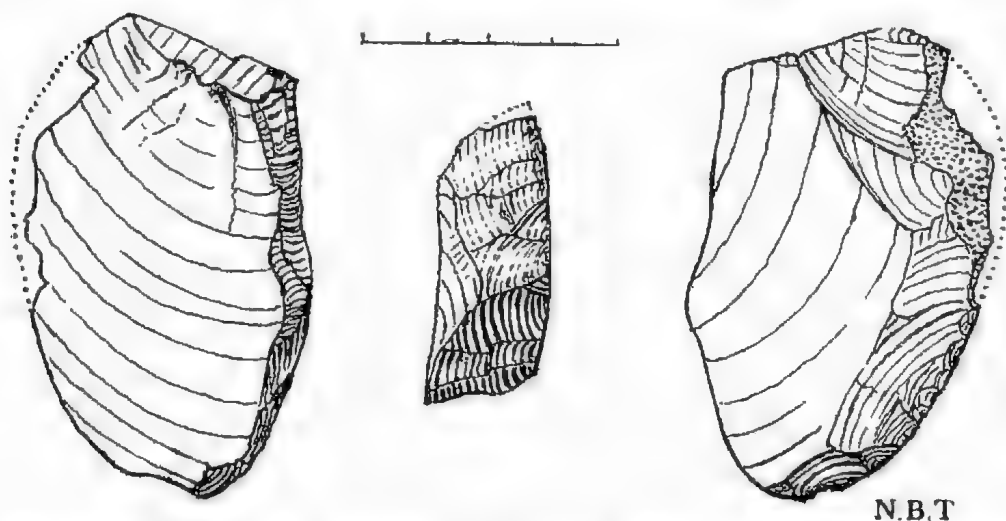


Fig. 4.—Three views of flint implement in B horizon of red soil at Cape Martin, numbered as A.39664 in South Australian Museum (scale registers centimetres).

implement, of a style characteristic of implements of the Tartangan culture in many other places in South Australia. This feature is also found on many implements of the recently extinct Tasmanians (Tindale, 1937; Campbell and Noone, 1944, p. 384) as well as on some gum hafted general purpose knives made by present day aborigines of the Pilbara district and inland from La Grange in North-Western Australia (Tindale, 1957).

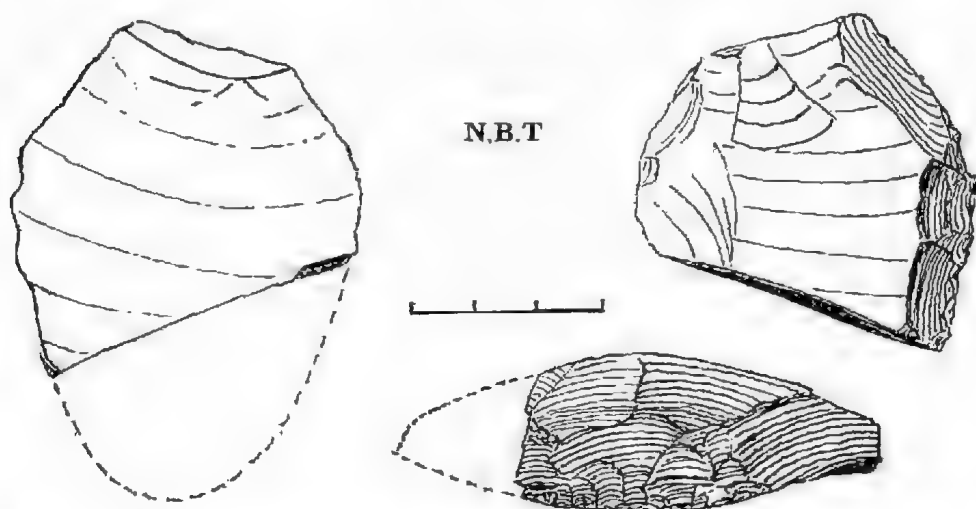


Fig. 5.—Three views of portion of an implement found in the A horizon of red soil at Cape Martin.

The butt half of an implement (Fig. 5) closely similar to the first example was found *in situ* in the A horizon of the same soil, a few yards off in a part where recent erosion had not yet stripped away this horizon. Although only a few centimetres higher in the soil profile, the process of chemical change had not so completely reduced the specimen to chalk and this proved to be the case generally with others found in the A horizon. Where implements occurred, the red soil usually appeared slightly more limey than elsewhere, there were particles of charcoal in the soil, and the implements occurred among food shells. The dominant member of this shell suite was *Chione*, with some *Brachyodontus*, as also *Paludina* shells of large size (suggesting that they might have been used as food). At first there appeared to be an entire absence of rock-frequenting types of shells, but one or two fragments of *Turbo undulatus* were subsequently found when washing blocks of hearth to float out carbon fragments.

On the second visit many further flint chippings, as well as several useful examples of implements, were found *in situ*. Figure 6 shows four views of a rather crudely trimmed block, which except for its slightly larger size, closely matches one of the original Tartangan specimens figured by Hale and Tindale (1930, fig. 21). In some ways it resembles also the cutting stone of a *kodj* axe (Tindale, 1950). Forming part of the hearth from which the tested carbon sample was removed, were several stones of the type called oven stones. These are roughly tabular and spherical pieces of sandy rock which have been burned and blackened in fire. Similar stones were used by present day aborigines as foundation stones of hot hearths on which to lay food for steaming.

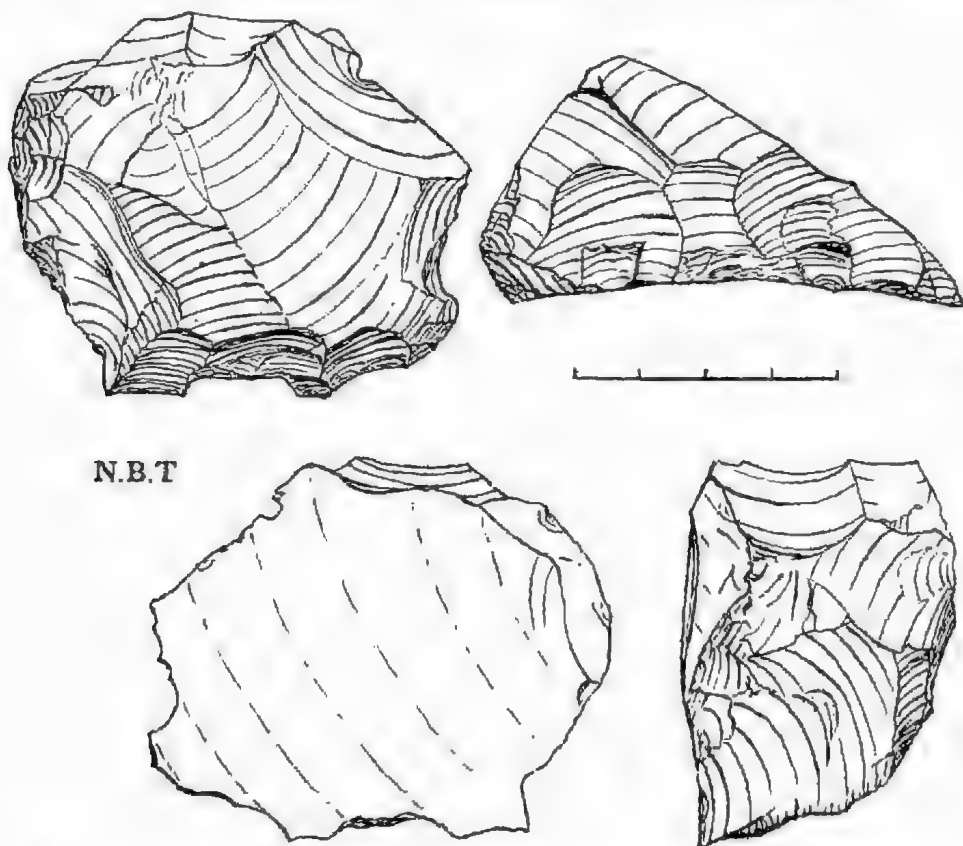


Fig. 6.- Four views of a discoidal implement, made on a block, found in the A horizon of red soil, beside the dated hearth, at Cape Martin.

IMPLEMENTS FROM THE RED SAND OF SECTION 8, HUNDRED OF SYMON

Figure 7 (middle) shows a typical example, broken before it came to be deposited in red soil now lying between the summits of pillars of lime of the B horizon of this soil. The indications are that the implement came to rest in the red soil when this was the surface of the ground and during a phase when rain wash from the surrounding lime sand rises was increasing the depth of soil in the swale at this campsite. It could be inferred that the implement was in position before the kunkar pillars had grown so high as they are at present and that the implement, like others found nearby, seemed to belong to the same culture phase as the Cape Martin implements. These types of implements are highly characteristic of the older sands, occurring in and appearing commonly

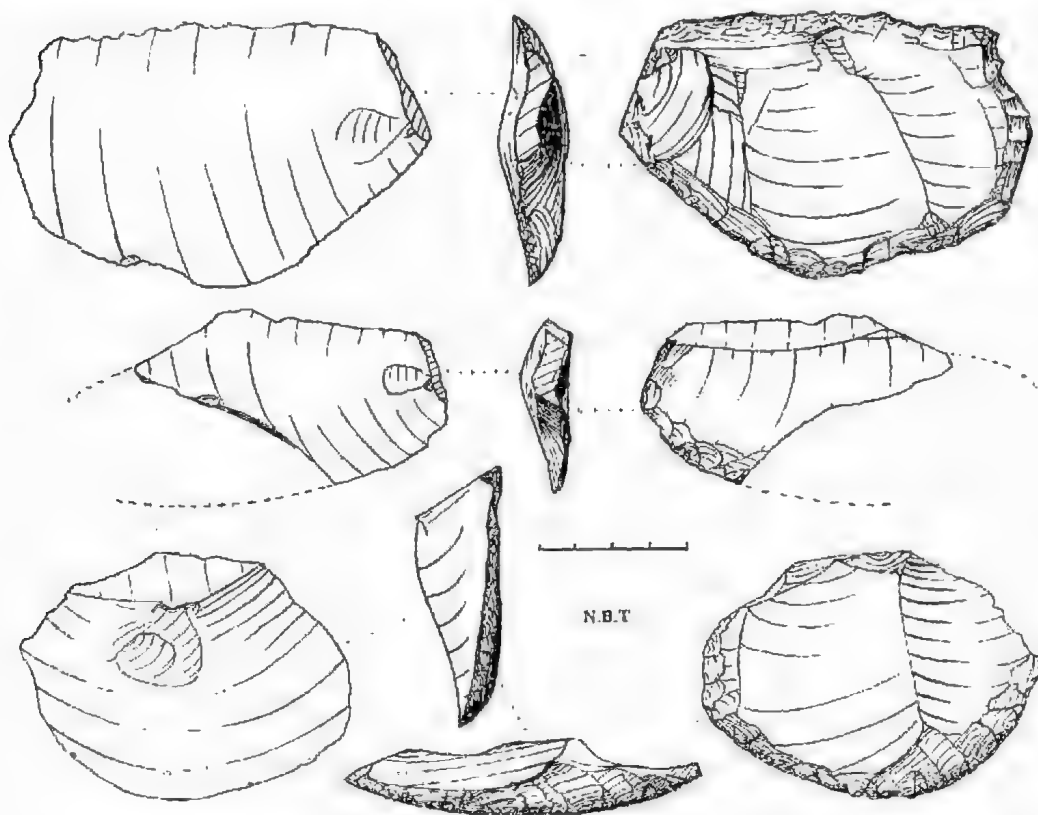


Fig. 7.—Top: Three views of a Tartangan long blade from a surface site 2 miles inland from Blackfellow Cave, collected by H. L. Sheard (A.28240 in South Australian Museum). Middle: Three views of snapped flint blade found within the A horizon of the red soil at Section 8, Hundred of Symon. (A.39649.) Bottom: Four views of a short blade, a surface find by T. D. Campbell, in the Hundred of Kongorong. (A.36896 in South Australian Museum.)

on eroded campsites at least as far to the east as Cape Bridgewater in Victoria and to the north-west in the Murray Valley. At Hoods Drift (Section 541, Hundred of Kongorong) this implement suite occurs in great abundance in the corresponding red sand layers, with a microlith industry in an overlying sand of later date (Tindale, 1957).

Figure 7 (top) and Fig. 7 (bottom) show typical surface finds of Tartangan knives, one from a place two miles inland from Blackfellow Cave and the other from Kongorong for comparison with the example from Symon. Campbell and

Noone (1944) and Campbell, Cleland and Hossfeld (1946) have given details of these and numbers of other sites on which such implements occur. They have not drawn particular attention to the stratigraphy or cultural successions evident at the sites, being in general more interested in the microliths of the Mudukian horizon which occurs overlying the Tartangan sites at many places. Some details of the stratigraphy of these sites are being given in a separate paper (Tindale, 1957).

IMPLEMENTS OF THE LATER SITE AT CAPE MARTIN

The implements of the upper site at the Cape were rare, there being many more waste flakes than finished implements, perhaps indicating that the main camp was elsewhere and that the site was used chiefly as a temporary halting place near the sea while engaged in cooking the very abundant *Turbo* food shells.

Among the living aborigines this shell-gathering and cooking task fell to women folk. Among the Tanganekald and Potaruwutj, women generally were not in the habit of using knives, instead they used as a domestic knife the edge of their thumbnail, which they kept well sharpened. Even in Post-European times some women could not be induced to use European knives because of the influence of this prejudice.

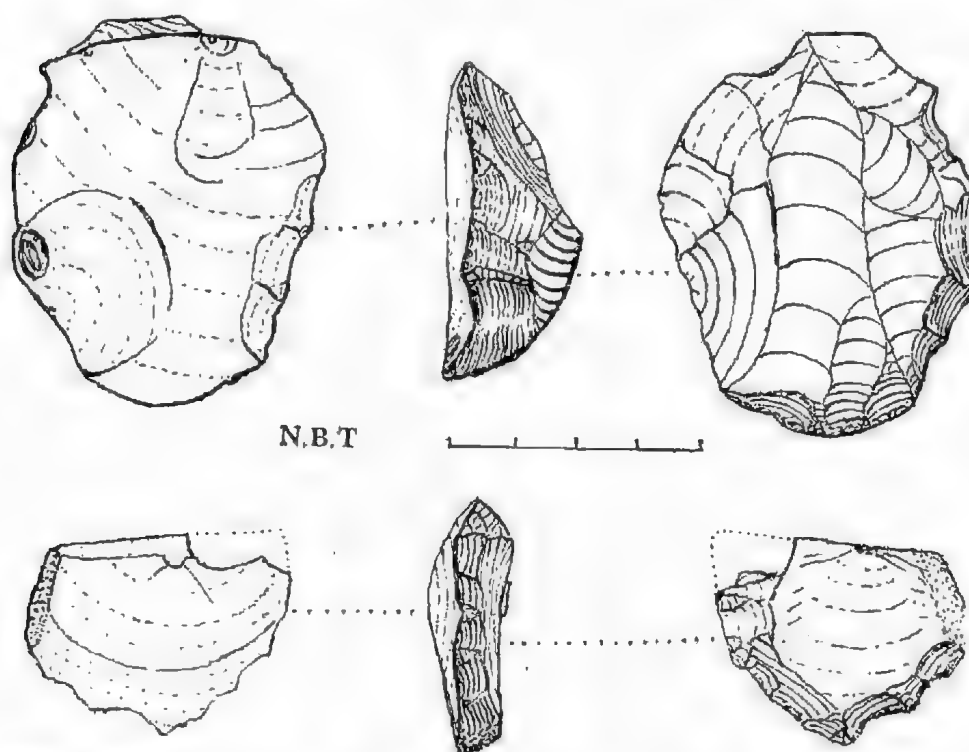


Fig. 8.—Implements in the Upper or Murundian layer at Cape Martin. Top: Three views of high-backed scraper (A.39667 part). Bottom: Three views of adze stone (A.39667 part).

Two main types of implements were present. The more common were adze stones, made on flakes struck off from a prepared core leaving a striking platform almost at right angles to the flake surface. Figure 8 (bottom) shows a typical example. It can be matched with hafted specimens obtained from the living people of the area in the early days of settlement, and with ones in the

uppermost ten feet of deposit in the Devon Downs Rockshelter (Hale and Tindale, 1930).

The second type is the so-called high-backed scraper, of which a typical example is given in Figure 8 (top). These are made indifferently on thick flakes and on blocks of flint. The high-backed scraper seems to occur in all of the culture horizons back at least to the Pirrian.

The flints from this upper horizon are only slightly patinated, generally to the extent that the dark flint has become paler and assumed a faint bluish-white bloom; some pieces look quite fresh.

IMPLEMENTS OF THE MARNIONG MOUND AT CAPE NORTHUMBERLAND

The implements from the mound at Section D, Hundred of MacDonnell, include the same two types as are present in the Upper campsite on Cape Martin. Some of the adze stones show a notched cutting edge and others a somewhat more pointed profile, but by viewing the cutting edge of the stone from the plane in which the adze meets the work it can be seen that both types would have made a rather flat, chisel-like cut on the wood, and the differences are those which arise casually in the course of repeated resharpenings when in use. Figure 9 contrasts the two adze-stone forms which seem to have originated in this manner. Hammerstones and edgedround axes of igneous rock, traded from

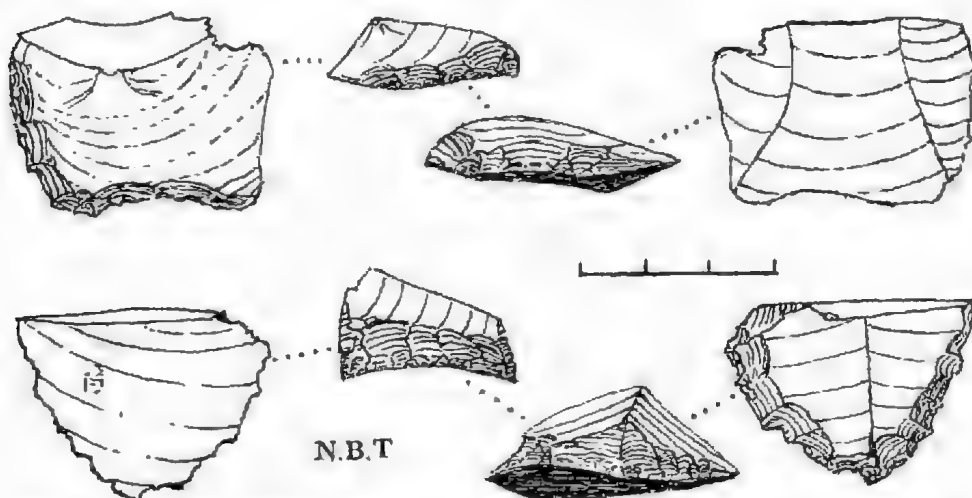


Fig. 9.—Implements in the Upper or Murundian layer of the *marniong* mound at Section D, Hundred of MacDonnell, Cape Northumberland. Top: Four views of notched-edged adze stone. Bottom: Four views of another adze stone (numbered as A.30537 in South Australian Museum).

the stone mine at Mt. William in Central Victoria and from the site near Chatsworth on the Hopkins River, have been reported from the mound and its vicinity which is so frequently visited that such objects tend to be picked up and carried away as soon as they are revealed at the surface by wind erosion.

From the juxtaposition of the mound to the only track down to the North Beach, the fact that marine erosion, though rapid, has not had time to remove the path, and the knowledge that this was one of the sites in use by the aborigines in the earliest days of white settlement, it seems likely that Murundian Culture implements continued to be made and used on the site until within less than one hundred years ago. Pieces of European claypipe stem and early coins have been found.

The implements from the surface of the kunkar, presumptively of the older Tartangan culture, include typical blades like those at Cape Martin, and a broken portion of a tabular piece of flint which is worked rather poorly on the two opposite faces.

THE DATING OF THE CAPE MARTIN SITE

We are indebted to Mr. G. F. Fergusson of the Dominion Physical Laboratory at Lower Hutt, New Zealand, for making a Carbon 14 determination of the age of the hearth in the A horizon of the red earth soil at Cape Martin. When the Carbon specimen was sent for study the following description was given: "A.48257. Wood carbon from Cape Martin near Beachport, South Australia, collected by N. B. Tindale, 16 November 1955. At this site implements of Tartangan facies are present in a red earthy horizon, with a predominantly estuarine shell fauna. It was overlain by a great thickness of white sand dune, on which there is a Murundian culture horizon with a suite of reef shells similar to ones occurring on the shores of the present Cape. This carbon sample was broken out and separated by washing from the ash and charcoal layer at the same horizon [A] as the suite of classifiable implements. It might give a date as early as or even earlier than 6000 B.P."

Mr. G. F. Fergusson's reply was: "Age with respect to modern wood standard = $8,700 \pm 120$ years".

Two other Carbon 14 dates are available which seem to confirm the early date for the Cape Martin site. At Lake Menindee *Unio* shells from Horizon B in Area I, collected, at the author's request, by Mr. L. F. Marcus, and also tested by Mr. Fergusson, have yielded the date of $6,570 \pm 100$ B.P. The implements in this bed were assessed by Tindale (1955) as Tartangan and established to be in association with a suite of extinct species of mammals (Tedford, 1955). Full details of this C 14 date are given in Tindale (1957) where a C 14 date of $6,020 \pm 150$ B.P. based on *Unio* shells tested at Columbia University is recorded for a late phase (Layer C) of the Tartangan beds at the type site on Tartanga Island, in the River Murray, South Australia (Hale and Tindale, 1930).

DISCUSSION

From the data at Cape Martin given in this paper and that learned from work reported previously it is possible to draw up the accompanying table, Figure 10, showing the succession of cultures in the Murray Valley and surrounding areas.

As a result of the obtaining of C 14 dates it has been possible to replace a time scale based purely on geological data with one given in years, without materially disturbing the pattern and general ideas on time range which had been developed by the study of the cultures themselves and their relationships to such geological phenomena as the eustatic terrace of the Mid-Recent (10 ft. Terrace) and other shoreline structures associated with late phases of the Pleistocene glaciation.

By contrasting the Tartangan of Lake Menindee (6500 B.P.) with the similar culture at Tartanga (6020 B.P.) we seem to get an indication that the critical centuries when the great Pleistocene assemblage of Australian mammals was declining towards extinction fell after 6500 B.P. The only unusual species present at Tartanga after about 6000 B.P. were a *Macropus* with a fourth molar differing in that its width exceeded by 18 p.c. the value characteristic of modern *M. giganteus*, and a species of *Sarcophilus* which persisted until Mid-Mudukian times before becoming extinct.

It is of interest to note that mammal bone does not preserve well in the dune sands of the South-East of South Australia so that even in Mudukian sites,

deduced to be only about 2000 years old, bones are virtually absent. No mammal bones of any kind have been found in the red beds at Cape Martin, and so far they have not been reported from any other sites in the area which might be termed Tartangan. It can be expected that when a suitable shelter or cave is discovered containing Tartangan remains which have been protected from

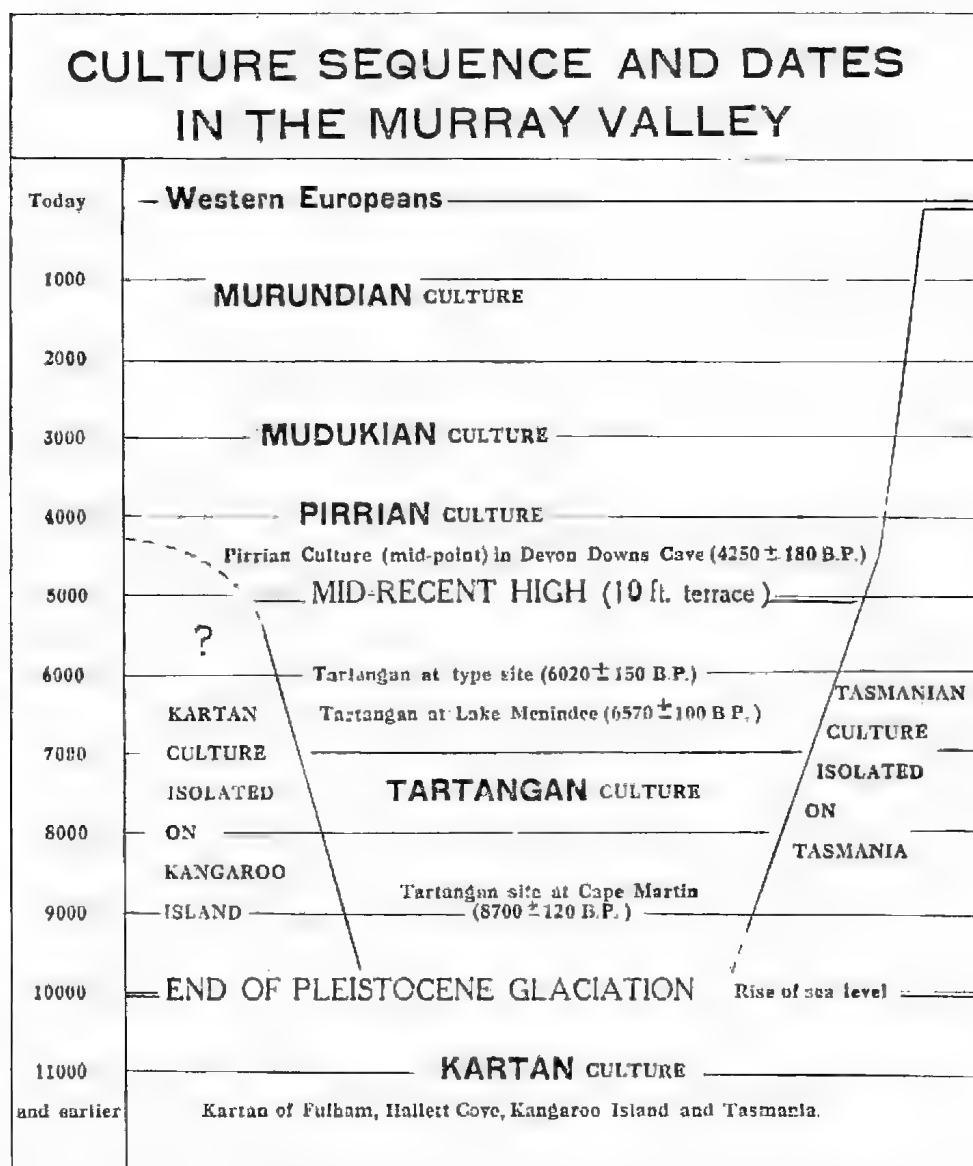


Fig. 10.—Diagram indicating culture sequences and dates in the Murray Valley and vicinity, South Australia.

weathering a rich fauna of extinct Pleistocene mammals should be found in association since it is unlikely that all the fossil species would have disappeared from the coastal areas by 8700 B.P., since some are shown to have survived at Lake Menindee until after about 6500 B.P.

The evidence afforded by the *terra rossa* soils, seemingly perched on old lime sand dunes, points to the formation of these soils by the carrying down, into the depths of the dunes, of the surface lime, leaving the siliceous and iron residues at the surface, the whole indicating the existence of periods of high rainfall when extensive leaching would occur. Under present day conditions with a winter rainfall of around 30 inches, it is a matter of observation that sufficient lime is dissolved and re-deposited near the surface to cause calcareous cementation of the dune sands and formation of slightly indurated layers up to one inch in thickness in the course of a single season. Such crusts occur in the mobile sands almost down to storm tide mark. In other mobile sands, several hundred yards and more inland, for example on Cape Buffon Peninsula, where new sand is constantly being added, harder and softer horizons appear as "varve"-like alternations of indurated and soft sand. They may either be the record of periodic rainstorms or of the annual succession of dry and wet seasons.

In general, red soils are found as a covering on each of the inland dune ranges of the South-East of South Australia. Those on the older lime sand ranges are deeper than those at, for example, Cape Martin, where the soil must be relatively young. It would seem that the red soils are of several ages and all are *in situ* and that it is the greater lapse of time since the formation of the earlier dune ranges that has permitted leaching away of the lime to greater depths; hence yielding greater thicknesses of *terra rossa* soil.

Under summer conditions in the South-East of South Australia, upward moisture movements have been observed in the limestone pillars, forming an aura of dampness in the soil about their summits, which suggests active vertical growth of the tips of the limestone pillars within the red soil cover.

The view that the red soils may be an expression of wet climate, expressed in the above paragraphs, seems to be at variance with some current ideas, which appear to demand arid periods at important stages of the formation of the red soils.

To Mr. B. E. Butler who has studied the red soils of South-Eastern Australia (Butler, 1956), I am indebted for examining samples of the soils from Section 8, Hundred of Symon, and from Cape Martin. His comments in a letter, under date of 6 June 1956, are as follows:

"Our present thinking supports fairly clearly three phases of aridity: the most recent being least severe and comprehensive. There may be earlier arid phases, too. These arid phases were separated by wet phases during which the soils were leached and broadly one may say that the earlier of these phases was also more intense and of a longer duration than the later phases. The stratigraphic relationships and the depths of leaching can be used to distinguish the materials of one phase from those of another. Of the samples you have sent, the first, an A horizon from Cape Martin, is probably to be related to the latest aridity because it contains discrete particles of lime. We find evidence of this phase of aridity extending from the south-west towards Swan Hill (Victoria), but not extending very far further eastward. Its chief manifestations were instability of dune crests and lunette building. Your second sample is not clearly indicated as to whether surface or sub-surface sample: it is non-calcareous, more clayey than sample no. 1 and might be older. Both samples could be wind distributed materials and are similar to the materials we encountered at Swan Hill where a study of these phases is being done by Mr. H. M. Churchward. We have still to finalise the criteria for distinguishing these arid phases especially in the cases where the record is incomplete. We have reached no finality as to the dates of these arid phases: all we propose is their relative intensities and the duration of the intervals. The figure of 6-8,000 years for the most recent aridity would not be in discord with our existing evidence."

Gill (1955) has postulated afresh an Australian 'Arid Period' connected with the mid-Holocene Warm Phase, or Thermal Maximum, called the 10 ft. Terrace period in this paper, and in Europe called the Climatic Optimum. The mid-point of this time he places at about 5000 B.P. The presence of loess dune formations is used as evidence of the dry conditions.

The present author (Tindale, 1947, 1952, 1953, and 1955) had drawn attention previously to zoological data which seemed to deny the existence of a Mid-Holocene arid period in Southern Australia, such as was first pronounced by Crocker and Wood (1947). Their theory had leaned heavily on soil evidence.

Gill did not accept the zoological data as affording sufficient evidence to warrant abandonment of the 'Great Arid' theory, although Condon (1954) and Cross (1955) had shown by additional zoological data that it was relevant.

The C 14 dates now available for the Tartangan culture horizons discussed above, and in particular the minimum date of 8700 B.P. for the *terra rossa* soil at Cape Martin destroys the loess basis on which the theories of a Mid-Holocene arid period were conceived. It may be pointed out that the C horizon of the red soil in the swales at Cape Martin can be many feet thick and the hearth in the A horizon indicates that it must have already been in process of development long before the date when the most superficial layers of it afforded space for the camp of Tartangan men.

ACKNOWLEDGMENTS

The author is indebted to Mr. G. F. Fergusson of the Dominion Physical Laboratory, Lower Hutt, New Zealand, for the age determination for Cape Martin as also for those from Lake Menindee incidentally referred to herein. Mr. H. Burrows prepared from my field sketches the several diagrams and the map illustrating this paper.

The names of colleagues, with whom discussions of the subject have been most profitable, are given in an earlier section of the paper.

It should not be forgotten that the group of workers interested in archæology at Adelaide all profited greatly from the stay among them of Mr. H. V. V. Noone, whose recent death is a loss to all. He was a fellow of the Royal Society of South Australia and a contributor to its Transactions.

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CESTODES FROM CORMORANTS FROM SOUTH AUSTRALIA

BY HELEN GOLDTHORP CLARK

Summary

This paper deals with six species of cestodes from South Australian cormorants. It was found on examination of the type material that Goss (1940) had confused two species in her description of *Paradilepis minima*. These two species are redescribed and identified as *Paradilepis scolecina* (Rudolphi 1819) and *Paradilepis minima* (Goss 1940, in part). *Paradilepis* sp. is recorded but not named, as the material was inadequate. *Dilepis maxima* Goss 1940, *Hymenolepis cormoranti* Ortlepp 1938 (Woodland 1929) are redescribed from fresh material.

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This paper deals with six species of cestodes from South Australian cormorants. It was found on examination of the type material that Goss (1940) had confused two species in his description of *Paradilepis minima*. These two species are redescribed and identified as *Paradilepis scolecina* (Rudolphi 1819) and *Paradilepis minima* (Goss 1940, in part). *Paradilepis* sp. is recorded but not named, as the material was inadequate. *Dilepis maxima* Goss 1940, *Hymenolepis cormoranti* Ortlepp 1938 (Woodland 1929) are redescribed from fresh material.

From the one bird found in Adelaide, a little pied cormorant, *Microcarbo melanoleucus* (syn. *Phalacrocorax ater*) we obtained a specimen of *Dilepis maxima* Goss 1940, two fragments recorded as belonging to a species of *Paradilepis*, and numerous specimens of *Hymenolepis phalacrocorax*. The latter also occurred in four little pied cormorants collected at Tailem Bend, together with numerous specimens of *Paradilepis minima* (Goss 1940). The latter were also found in two little black cormorants, *Phalacrocorax sulcirostris*. In another little pied cormorant from Tailem Bend we found thirteen specimens of *Hymenolepis cormoranti* Ortlepp 1938. Many specimens of *Paradilepis scolecina* (Rudolphi 1819) were obtained from one black cormorant (*Phalacrocorax carbo* var. *novae-hollandiae*).

This work was started under the direction of the late Professor T. Harvey Johnston, with the intention of producing a joint publication, which was unfortunately prevented by his death in 1951. I should like to express my gratitude for his great help with the paper, while making it clear that the opinions expressed are the sole responsibility of the author. Thanks are due to Messrs. G. G., Fred and Bryce Jaensch of Tailem Bend, and the late Mr. L. Ellis of Murray Bridge for obtaining the birds from Tailem Bend for us. I also wish to thank Miss Goss, formerly of University of Western Australia, for very kindly allowing me to re-examine her slides of *Paradilepis minima*. The work was done with the assistance of the Commonwealth Research Grant to the University of Adelaide.

Paradilepis scolecina (Rudolphi 1819)

Figs. 1-9

Syn. *Paradilepis duboisi* Hsü 1935; *Paradilepis brevis* Burt 1940;
Dilepis minima Goss 1940 (in part).

Numerous specimens were obtained from *Phalacrocorax carbo* var. *novae-hollandiae* shot at Tailem Bend, S.A. Those with eggs measure 3.5-4.5 mm. long with a maximum breadth of 0.32-0.44 mm. and have about 80 segments, all broader than long.

The scolex is 0.42-0.48 mm. (average 0.47 mm.) in diameter. The broad muscular rostellum, 0.17-0.2 mm. in maximum diameter when everted, has 20 hooks arranged in a double crown, the two series alternating and with hooks differing in shape and size (Figs. 2 and 3). The anterior hooks measure 0.111-0.114 mm., average 0.112 mm., in total length, the posterior 0.075-0.081 mm. (average 0.079 mm.) in total length; all have a long dorsal and a short ventral root. These hooks are readily lost and hence were not present in much of our material. The large rostellar sac extends back almost to the level of the posterior

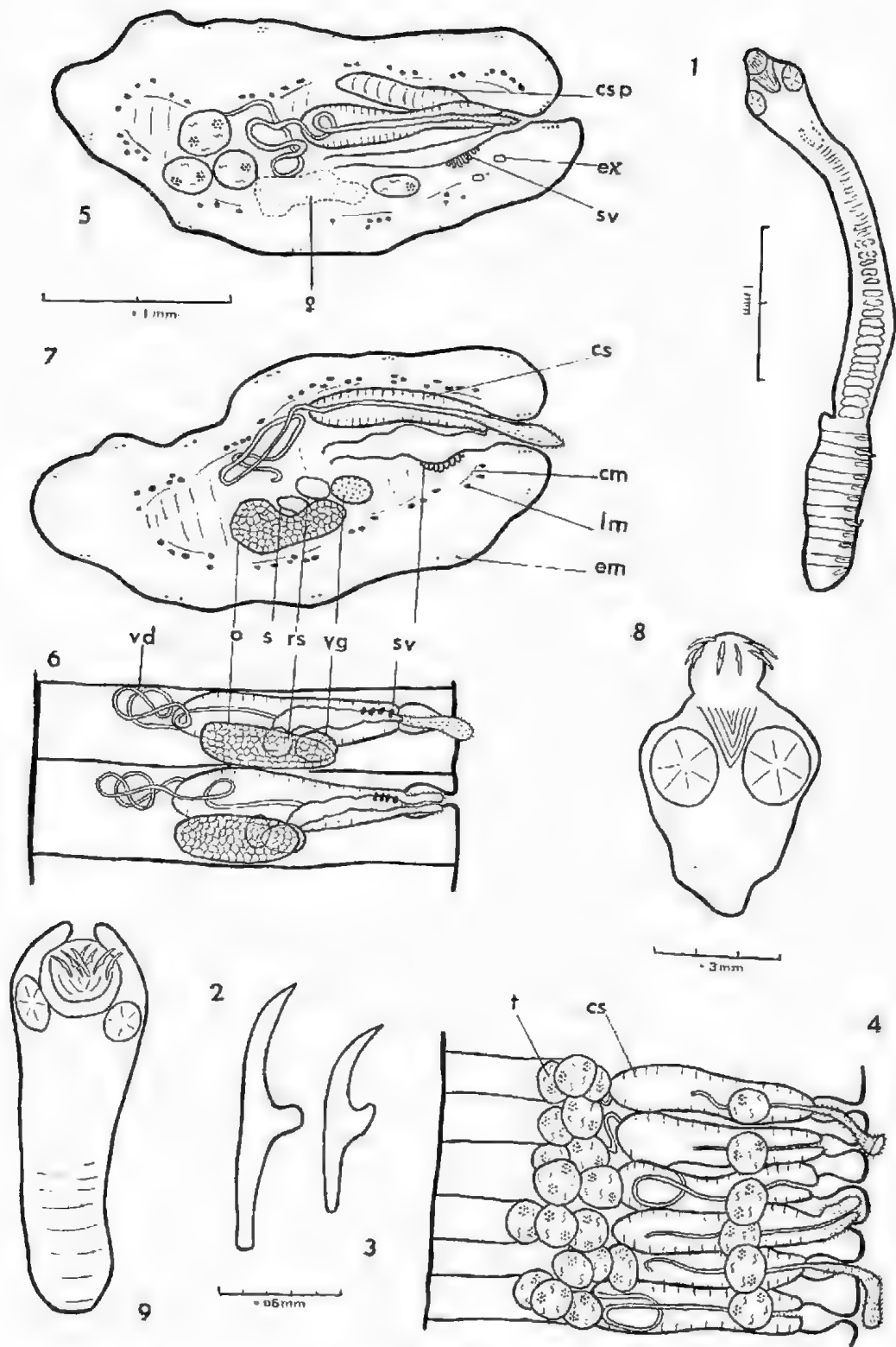


Plate 1.

Figs. 1-9.—*Paradilepis scolecina*. 1, mature cestode; 2 and 3, rustellar hooks; 4, ventral view of segments with mature testes; 5, transverse section of same; 6, ventral view of segments with mature ovaries; 7, transverse section of same; 8 and 9, young forms. Figs. 2 and 3 to same scale; Figs. 4, 5, 6 and 7; Figs. 8 and 9. cm, circular muscle; cs, cirrus sac; csp, cirrus sac from preceding segments; in, outer ring of longitudinal muscle; ex, excretory vessel; lm, inner ring of longitudinal muscle; o, ovary; rs, receptaculum seminis; s, shell gland; sv, sphincter of vagina; t, testis; vd, vas deferens; yg, yolk gland.

margin of the suckers. The latter are hemispherical or slightly ellipsoid and measure 0.1-0.14 mm. in diameter or 0.11-0.12 by 0.14-0.15 mm. The scolex merges into a neck varying in length and width according to the state of contraction.

Segments just behind the neck are 0.32-0.44 mm. broad by 0.02 mm. long. They narrow slightly (to 0.25-0.29 mm.) and gradually lengthen as they mature, becoming 0.03 mm. long at sexual maturity, 0.04 mm. long in segments with a developing uterus, increasing to 0.12 mm. in those with a gravid uterus. Some strobilae show a sudden increase in width when the uterus is fully developed.

Calcareous corpuscles are elliptical. The outer longitudinal muscle ring consists of a few scattered fibres in the cortical region. The inner ring contains much larger fibres. The genital ducts pass outwards dorsally to both excretory canals.

In our specimens the testes tend to become displaced so that the organs may overlies in such a way as to make it difficult to distinguish them in whole mounts. The cirrus sac is so large that it occupies a considerable part of the segment at male or female maturity. The four testes develop before the ovary and have disappeared by the time the latter is fully developed. One testis lies porally and ventrally to the cirrus sac, the other three being on the aporal side. When mature they measure 0.026-0.037 mm. The vas deferens is very long, its numerous coils lying dorsally to the three aporal testes. The duct is also thrown into loops in the inner part of the cirrus sac but seminal vesicles were not recognizable. The cirrus is armed with small spines and must be relatively very long, about 0.06-0.07 mm. when fully everted. The cirrus sac may measure 0.12-0.15 by 0.03 mm., but is somewhat smaller in gravid segments. The genital atrium may be deep and narrow (0.026-0.033 mm. in length).

The aulage of the female system can be recognized in segments with mature testes, lying ventrally between the poral and aporal groups. When mature the compact ovary measure 0.06-0.07 by 0.035-0.045 and lies ventrally below the inner end of the cirrus sac. The small yolk gland, about 0.026 mm. in diameter, is somewhat dorsal to the ovary. The small thin-walled receptaculum seminis lies on the aporal side of the vitellarium. The wide vagina travels inwards just behind and parallel with the cirrus sac to enter the seminal receptacle. Near the female pore it has well-developed muscle fibres.

The uterus develops ventrally and extends gradually till it occupies most of the segment. Eggs are about 29-35 μ in diameter; the onchospheres about 16-20 μ in diameter and their hooklets 9.5 μ long.

Immature forms. Several were recovered from the intestine of the same cormorant. One (Fig. 8) had not advanced much from the cysticeroid stage and measured 0.67 by 0.43 mm., with rostellar hooks 0.11 and 0.078 mm. in total length. The only one of the remainder still possessing hooks (Fig. 9) had already begun to form a strobila and measured 0.95 by 0.33 mm. with hooks 0.11 and 0.08 mm. long. Both contained numerous calcareous corpuscles.

Since this species seems to have been confused in Australian literature with *P. minima*, the systematic position of the two is discussed later.

***Paradilepis minima* (Coss 1940)**

Figs. 10-16

Syn. *Dilepis minima* Coss 1940 (in part).

Numerous specimens of this small cestode were obtained from the stomach and intestine of three *Microcarbo melanoleucus*, syn. *Phalacrocorax ater* and from two *Phalacrocorax sulcirostris*, all taken at Tailm Bend.

Egg-bearing worms measure 1.5-2.3 mm. in length and 0.26-0.38 mm. in maximum width. Youngest segments are 0.26-0.3 mm. broad and about 0.02

mm. long. As they mature they reach their maximum width and their length is about 0.037 mm., but they continue to lengthen as they become gravid when the dimensions may be 0.26-0.28 mm. in breadth and 0.15-0.17 mm. in length. Sometimes these latter tend to separate partly from their fellows so that the posterior part of the strobila may resemble a string of beads.

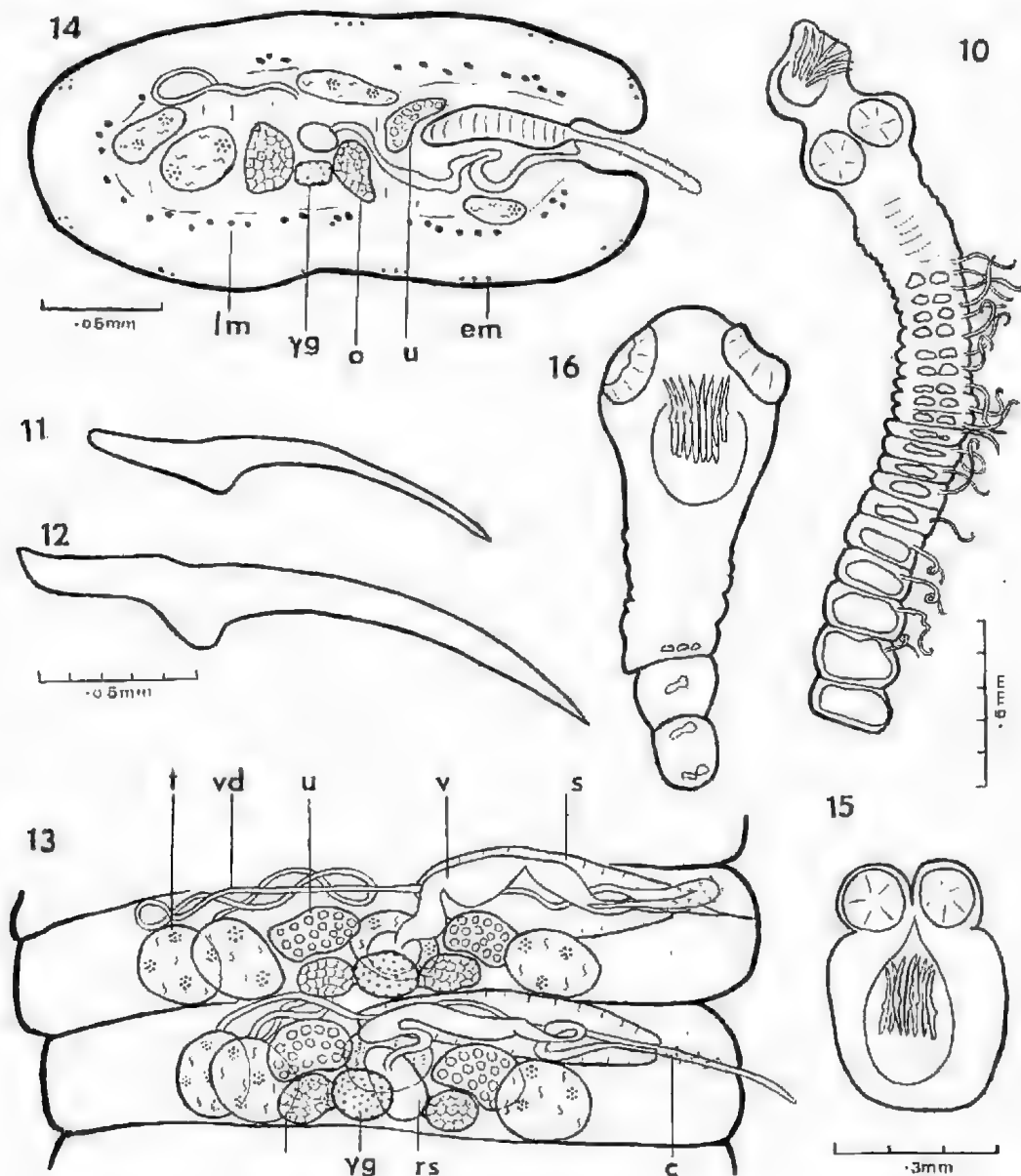


Plate 2.

Figs. 10-16.—*Paradilepis minima*. 10, mature cestode; 11 and 12, rostellar hooks; 13, ventral view of mature segments; 14, transverse section of same; 15 and 16, young forms. Figs. 11 and 12 to same scale; Figs. 13 and 14; Figs. 15 and 16. c, cirrus; cs, cirrus sac; m, outer ring of longitudinal muscle; lm, inner ring of longitudinal muscle; o, ovary; rs, receptaculum seminis; t, testis; u, uterus; v, vagina; vd, vas deferens; yg, yolk gland.

The scolex is not well marked off from the neck region. When the rostellum is fully everted the scolex is 0.44-0.49 mm. long by 0.33-0.34 mm. broad, the rostellum being 0.167-0.2 mm. long by 0.15-0.16 mm. wide. The rostellar sac is large and extends back almost to the posterior margin of the suckers; when the rostellum is retracted, the sac measured 0.22-0.33 mm. long by 0.15-0.19 mm. broad. The well-developed musculature associated with the sac and rostellum closely resembles that present in *P. scolecina*. There is a double crown of 28 alternating hooks, the anterior 14 being 0.18-0.19 (average 0.184 mm.) in total length, the posterior smaller hooks being 0.125-0.13 mm. (average 0.127). These hooks seem to become dislodged readily since few worms have retained the full number. The suckers are 0.11-0.155 mm. by 0.13-0.155 mm.

The musculature of the segments is arranged as in *P. scolecina*. The excretory canals were not recognized.

The four testes develop a little before the ovary and attain their maximum size in segments containing developing ovary and yolk gland. One testis is paroral and lies ventrally to the large cirrus sac, one is median and dorsal to the ovary and the other two are aporal. When mature they measure 0.04-0.05 by 0.02-0.03 mm. The vas deferens is very long and thrown into coils dorsally in the anterior region of the segment, in front of the genital glands. On entering the cirrus sac it becomes somewhat coiled as an inner vesicula seminalis. The thin-walled sac lies in the anterior part of the segment, parallel with the front border, and may extend to the middle of the segment. Its size is 0.11-0.13 by 0.03-0.04 mm. in mature segments. The genital atrium is narrow and deep. The cirrus is very long, about 0.25 mm. in length. Its proximal region bears numerous rose-thorn spines, about 5μ across the base and 5μ from the base to the tip, these spines becoming smaller and less numerous towards the free end of the organ where only fine hairs are present. Segments containing mature ovaries also possess degenerating testes.

The mature ovary has two lobes connected by a relatively long isthmus. The yolk gland and the receptaculum lie ventrally between the lobes and in the posterior region of the segment. The yolk gland is about 0.037-0.04 by 0.026 mm.; and the receptaculum 0.03-0.04 by 0.02-0.03 mm. The latter is more dorsally placed than the yolk gland. The vagina lies just ventral to the cirrus sac and travels inwards from the atrium in a winding course more or less parallel with it to reach the receptaculum. The uterus develops as a bilobed sac which enlarges to occupy most of the gravid segment. Eggs measure $31-35\mu$ in diameter; the onchosphere $20-30\mu$ in diameter and the hooklets $9-5\mu$ in total length.

Immature forms (Figs. 15-16) were also recovered from the stomach and the intestine of one of the cormorants. The hooks measured 0.12-0.18 mm. in total length; the suckers 0.10-0.15 mm. in diameter; and the scolex 0.31-0.34 mm. broad. Some were almost cysticercoids, while in others segmentation had just commenced. These young forms were from 0.4-0.9 mm. in length. Since *Microcarbo melanoleucus* feeds on freshwater fish and yabbies (*Parachanna destructa*), the cysticercoids of *P. scolecina* and *P. minima* recorded by us probably developed in either the fish or the crustacean.

Relationship of *P. scolecina* and *P. minima*

Miss Goss very generously permitted us to re-examine some of her slides of *Paradilepis minima*. We find that two small species have been confused under that name and that her material from *Microcarbo melanoleucus* contains the same two species that we have described above. One has at least 26 hooks measuring about 0.17 and 0.12 mm. in total length, and cirrus with large rose-thorn spines suggestive of *P. minima*; the other has about 20 hooks measuring about 0.09 and 0.07 mm. in total length, and a cirrus armed with short hair-like

spines as in *P. scolecina*. In the original account of *D. minima* the larger hooks are reported as 0.11 mm. long and the smaller as 0.10 mm., but in the scolex figured by Miss Goss and re-examined by me, they measure about 0.16 and 0.11 respectively, while a figured hook is 0.12 mm.

Since most of the original account refers to the species with the larger hooks we have taken that as representing *P. minima*, and to it we assign Miss Goss' figures 23, 26-32; figure 25 might refer to either species. Though *D. minima* was reported to possess only three testes, a fourth was detected by us adjacent to and just in front of that figured as occurring on the aporal side of the segment. The account of the cirrus with backwardly directed spines 5μ long, the two-lobed ovary and the position of the testes (one of which is median, unlike the condition in *P. scolecina* where three are aporal and one poral, none central) indicates *P. minima*. The possession of four testes in the segment and of two rows of rostellar hooks places the two species in *Paradilepis* Hsü 1935. Joyeux and Baer (1950, p. 91) regard the genus *Paradilepis* as comprising only six species, which they list, together with their synonyms. They consider *Paradilepis scolecina* (Rudolphi 1819), *P. duboisi* Hsü 1935, and *P. brevis* Burt 1940 to be synonyms, and consequently we have identified our cestode as *Paradilepis scolecina*. Using the key they suggest *P. minima* (not included in their paper) is differentiated by its small size (strobila less than 10 mm.) from *P. macracantha* Joyeux and Baer 1936, *P. simoni* Rausch 1949, *P. kempi* (Southwell 1921) and *P. delachauxi* (Fuhrman 1909). *P. urceus* (Wedl 1855) and *P. scolecina* (Rudolphi 1819) both measure less than 10 mm., but both have 20 hooks, while *P. minima* has 28, and its hooks are larger.

Paradilepis sp.

Figs. 17-20

Two fragments of a cestode were obtained from a cormorant (*Microcarbo melanoleucus*) collected from the Adelaide Botanical Gardens in 1923. The length of the larger is 1 cm., and its maximum breadth 0.2 mm.; in its most mature segments the testes and cirrus sac are defined although still immature. The second specimen is only just beginning to segment.

The scolex measures 0.34-0.47 mm. in diameter and 0.5 mm. in length. In both specimens the rostellum is retracted; it carries 27 hooks arranged in two rows; the larger hooks measure 0.173-0.180 mm. total length, and the smaller 0.124-0.138 mm. total length. Their shapes are shown in figures 18 and 19. Of the 27 hooks, there are 13 large and 14 small ones; probably the complete number is 28. The rostellar sac measures about 0.16 mm. in diameter and 0.26-0.31 mm. in length; it extends back behind the posterior level of the suckers. The suckers are round (0.167 mm. in diameter) or elliptical (0.14 × 0.11-0.13 mm.) in shape.

There are four, occasionally five, testes situated on either side of, and behind, the developing female glands. Those in the ripest segments measure 0.03 mm. in diameter, but it is doubtful if they have reached their greatest size. The cirrus sac is not yet fully differentiated; it lies across the anterior part of the segment, reaching a little beyond the middle of the segment. In the most mature segments it measures 0.1 mm. long by 0.03 mm. broad.

The female glands are indicated by an aggregation of cells between the testes, but they are not differentiated. No excretory canals could be recognized.

This species belongs to the family Dilepididae Fuhrmann 1907, because of its four testes and double row of hooks. As there are no gravid segments we cannot be sure of its correct position, but record it as *Paradilepis* sp. Using the key suggested by Joyeux and Baer (1950, p. 91) it then belongs to the group of species exceeding 10 mm. in length, but can be distinguished from them by the number and size of its hooks.

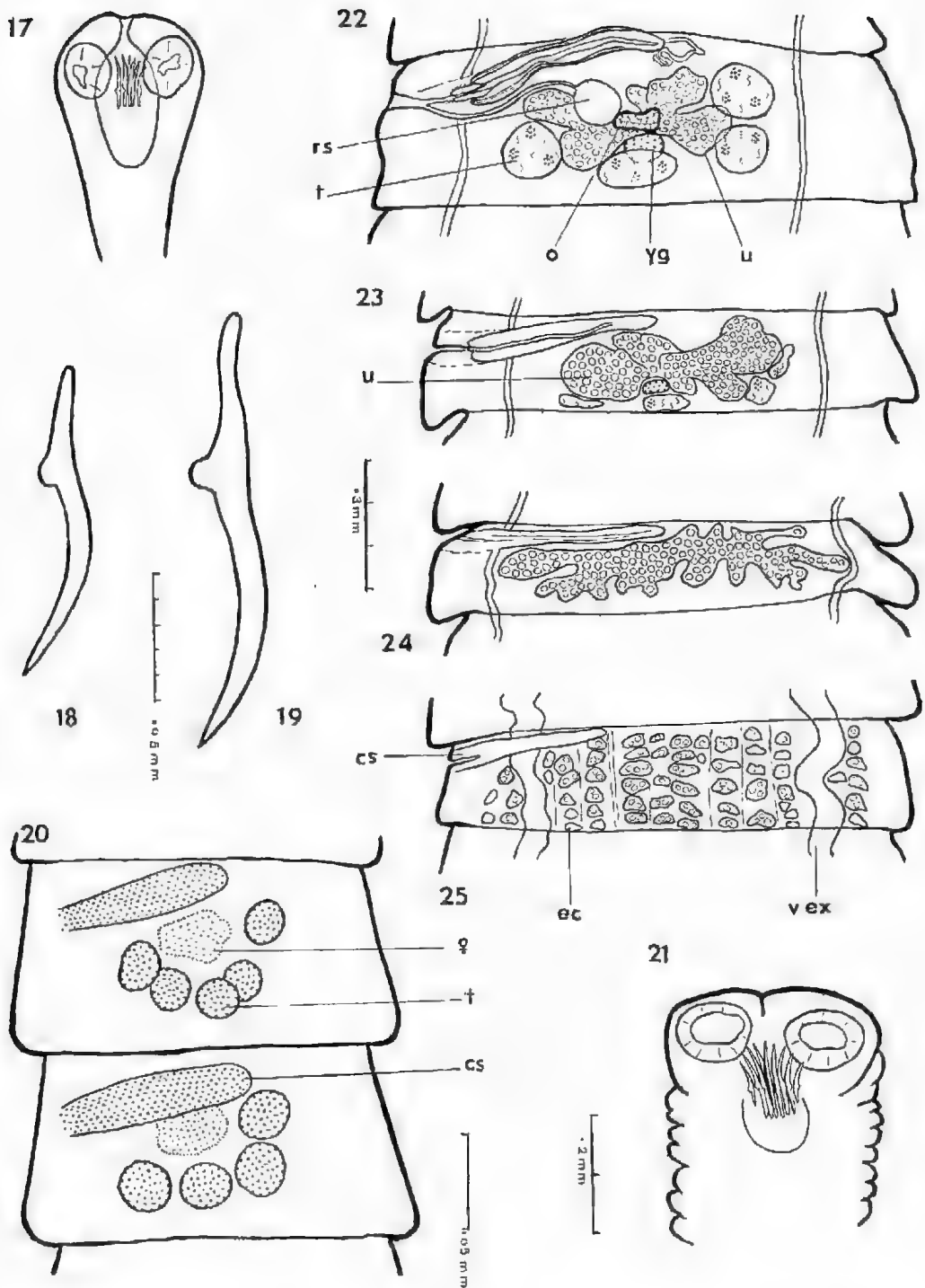


Plate 3.

Figs. 17-20.—*Paradileps* sp. 17, scolex; 18 and 19, rostellar hooks; 20, immature segment. Figs. 21-25.—*Dilepis maxima*. 21, scolex; 22, dorsal view of segment with developing uterus; 23 and 24, dorsal view of segments with branching uterus; 25, dorsal view of segment with ovigerous capsules.

Figs. 17, 23, 24 and 25 to same scale; 21 and 22 to same scale; 18 and 19 to same scale. cs, cirrus sac; ec, egg capsules; o, ovary; rs, receptaculum seminis; t, testis; u, uterus; vex, ventral excretory canal; yg, yolk gland; ♀, anlage of female organs.

Dilepis maxima Goss 1940

Figs. 21-25

A specimen of *Dilepis maxima* Goss (1940) was recovered from a small black and white cormorant, *Microcarbo melanoleucus*, collected in Adelaide, South Australia, in 1923. Its total length is uncertain (at least 5 cm.), but its maximum breadth is 1.2 mm. The scolex has a diameter of 0.36 mm. The rostellum carries a double crown of 26-28 hooks, the larger of which measure 0.153 mm. total length, and the smaller 0.108 mm.; in shape they are similar to those figured by Miss Goss (1940). The four suckers measure 0.13×0.11 mm.

In our specimen the anterior end is contracted and there is no distinct neck before segmentation begins. The genital ducts pass dorsally to the excretory canals. The unilateral genital pore lies in the anterior third of the margin of the proglottid.

The four testes measure each 0.07-0.08 mm. in diameter; two are situated on the aporal side of the female glands, one in front of the other; the other two are poral, one to the side of the female glands, and the other behind them. They persist in segments with well-developed uterus. The vas deferens coils before entering the cirrus sac. The pair of spines at the base of the cirrus, referred to by Miss Goss, could not be seen, but the cirrus itself is spiny. The cirrus sac is large, extending from the genital atrium across the anterior part of the segment; it measures 0.30-0.37 mm. long \times 0.03 mm. broad.

The mature ovary is median, and measures 0.07 mm. maximum diameter; the vitelline gland, situated directly behind it, measures 0.07 mm. in diameter. The vagina opens into the deep, narrow genital atrium just ventral and posterior to the opening of the cirrus sac; it runs parallel with the cirrus sac to the receptaculum seminis, which is situated dorsally in front of the ovary. At its largest, it measures about 0.08×0.05 mm. The uterus develops as two lobes which become branched, and finally break down into numerous egg capsules, extending laterally beyond the excretory canals, and containing each 1-20 eggs.

Our specimen is obviously *Dilepis maxima* Goss 1940, differing significantly from the original description only in the number of hooks (type specimen has 20) and in the size of the yolk gland (that of the type specimen measures 0.035 mm. in diameter). The type specimen may easily have lost several of its hooks, so that our number may be taken as more correct. The yolk gland in our specimen was measured from segments with developing uterini, which may account for its greater size. However, if the uterus really breaks down into ovigerous capsules, as it appears to do, this species does not belong to the genus *Dilepis*, which has a sac-like or lobed uterus, but to one of the genera of the subfamily Dipylidiinae. (The family Dilepididae Fuhrmann 1907 is divided into three subfamilies on the nature of the uterus; of these, the subfamily Dilepidiinae Fuhrmann 1907 includes those genera in which the uterus is sac-like, lobed or ramifying, and the subfamily Dipylidiinae (Stiles 1896) those in which the uterus breaks down into uterine capsules. (Fuhrmann 1932).) As we were not able to make certain that the appearance of the egg capsules is not due to a greatly ramifying and divided uterus, we have for the time left this species in its original genus.

Hymenolepis cormoranti Ortlepp 1938

Figs 26 and 27

Thirteen very small cestodes were obtained from a cormorant (*Microcarbo melanoleucus*) collected near Tailem Bend, South Australia, in March 1948. Unfortunately, none of the worms are mature, so that only a limited description of them can be given. The specimens measure up to 13 mm. long, with a maximum width of 0.3 mm. The scolex (Fig. 26) has a maximum diameter of

0.11-0.14 mm. It has a long rostellum ending in a bulb which carries the hooks; when fully everted the rostellum may be 0.44 mm. long. There is a single row of 10 hooks of similar shape and size, measuring 0.022 mm. total length. Their shape is shown in Figure 27. The four elliptical suckers measure 0.04-0.05 \times 0.055-0.065 mm. The scolex narrows slightly to the neck. In the most mature segments present, which are 0.037 mm. long, some of the organs are foreshadowed by aggregations of cells, but nothing of their number or arrangement can be determined.

These specimens resemble in general form, and in number and size of their hooks, three species which have been described from cormorants elsewhere. These are *Hymenolepis cormoranti* Ortlepp 1938, from *Microcarbo africana africanaoides*, whose 10 hooks measure 0.024-0.025 mm.; *Hymenolepis childi* Burt 1940 from *Phalacrocorax niger* of Ceylon, whose 10 hooks measure 0.021-0.022 mm. and *Hymenolepis gyogonka* Juhri 1941 from *Phalacrocorax javanicus* from Burma, whose 10 hooks measure 0.018-0.026 mm. All three cestodes are thin and delicate, and the arrangement and measurements of their internal organs do not differ significantly; none has such a long rostellum as our specimens, which may be because in none it is fully extended. Their hooks as figured, and those of our specimens, are all similarly shaped. Joyeux and Baer 1950 in a note to their paper consider that the three are synonyms. The South Australian specimens contain no mature segments, but in view of the close resemblance of the scolices to those of this group, they are provisionally identified as *H. cormoranti*.

Hymenolepis phalacrocorax (Woodland 1929)

Figs 28-31

Numerous specimens of this species were found in three little pied cormorants (*Microcarbo melanoleucus*) collected at Tailem Bend between 1938 and 1943 and one from the Adelaide Botanical Gardens collected in 1923. Unfortunately none has a scolex. The largest worms measure about 100 mm., with a maximum breadth of 1.14 mm., found in gravid segments. The unilateral genital pores are situated in the anterior third of the proglottid. All the segments are broader than long.

The muscular system is similar to that described by Woodland, the inner ring of longitudinal muscle fibres consisting of eight large bundles, four dorsal and four ventral. Immediately external to these is the outer ring of longitudinal muscle fibres, which is strongly developed. Both these rings lie within the ring of circular muscles, and are therefore medullary in position. There are the usual two pairs of longitudinal excretory vessels; the ventral ones are large (external diameter up to 44 μ) and the dorsal narrower with thicker walls (external diameter about 11 μ). No transverse excretory canals were observed. The genital ducts pass dorsally to the excretory vessels.

There are three testes, one poral and two aporal. As the segments are very short, they are usually transversely elongate, measuring 0.08-0.13 \times 0.07-0.09 mm. Their position with reference to the excretory vessels appears to vary. Usually the mature poral testis fills the dorso-ventral space behind the cirrus sac, most of it lying laterally to the excretory vessels. Both of the two aporal testes are crossed ventrally by the excretory vessels, the outer of the two being practically lateral to it, and the inner, practically median. All three testes lie between the longitudinal nerve cords. In segments with mature ovaries, the testes are completely lateral to the excretory canals, as figured and described by Woodland. There is an external seminal vesicle which may become extremely large; in segments with developing uterus, in which it is filled with sperms, it may measure 0.09-0.11 mm. wide, and fill the central portion of the segment. It begins

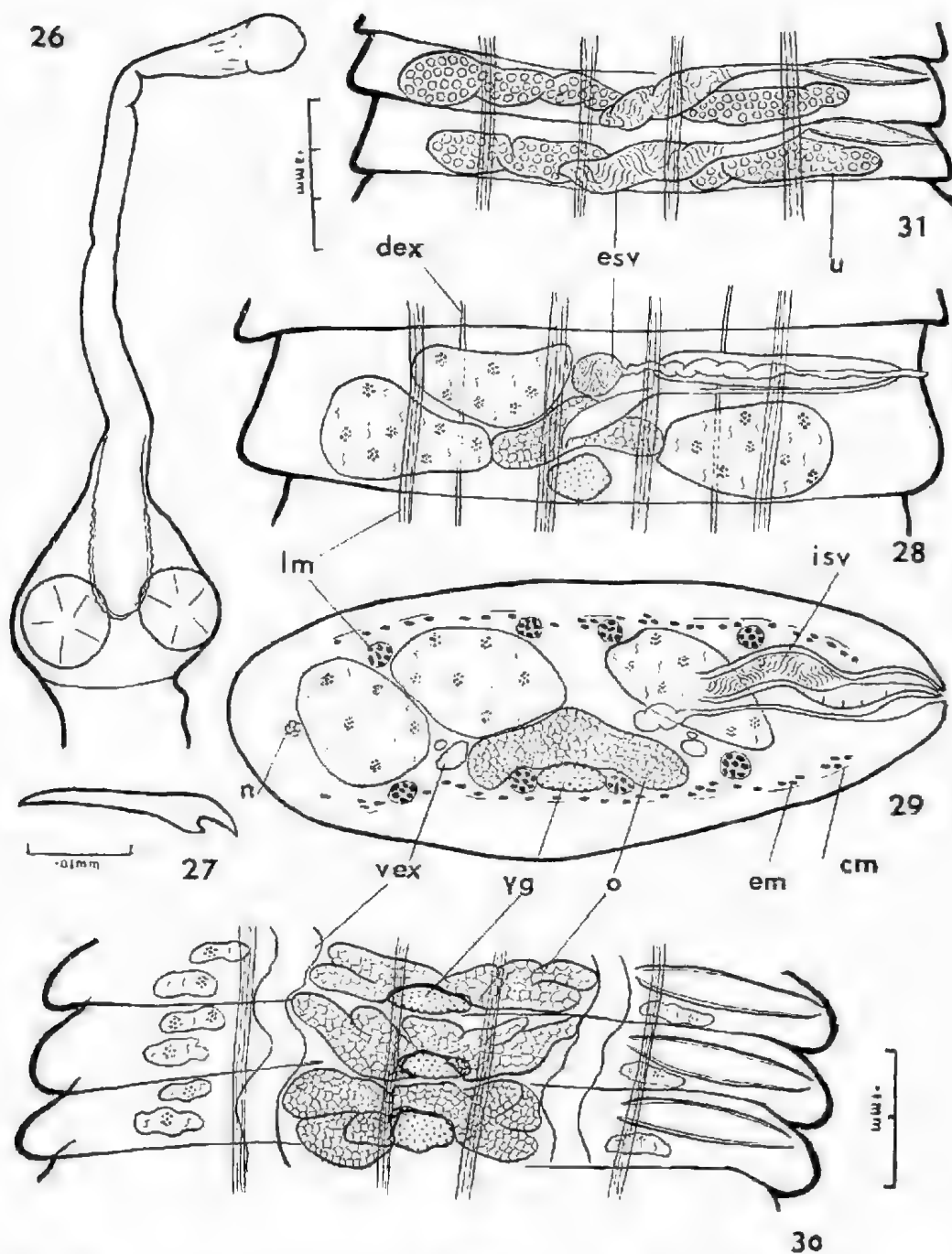


Plate 4.

Figs. 26-27.—*Hymenolepis cormoranti*. 26, scolex with rostellum everted; 27, rostellar hook. Figs. 28-31.—*Hymenolepis phalacrocorax*. 28, dorsal view of segment with mature testes; 29, transverse section of same; 30, dorsal view of segment with mature ovary; 31, dorsal view of segments with developing uterus. Figs. 26, 28, 29 and 30 to same scale. cm, circular muscle; dex, dorsal excretory canal; lm, outer ring of longitudinal muscle; esv, external seminal vesicle; isv, internal seminal vesicle; lm, inner ring of longitudinal muscle; vex, ventral excretory canal; yg, yolk gland.

abruptly below the cirrus sac and runs across the segment to the aporal excretory vessel, where it turns and comes back to enter the cirrus sac as vas deferens. Within the cirrus sac the vas deferens widens into an internal seminal vesicle which fills the cirrus sac when full of sperms. The cirrus itself is short (0.03-0.04 mm. long) and does not appear spiny. The genital atrium is shallow. The cirrus sac extends nearly up to or slightly beyond the poral excretory vessels. It measures 0.15-0.24 × 0.02-0.05 mm. in mature segments.

The bilobed ovary is large, measuring up to 0.20 mm. across when fully developed, extending between the excretory vessels that is, filling about one-third of the segment. Each lobe is subdivided into several smaller lobes. The slightly lobed yolk gland (0.048-0.055 × 0.02 mm.) is situated behind the ovary in its concavity. The receptaculum seminis is inconspicuous, appearing usually as a dilation of the vagina in the region of the ovary and dorsal to it. The vagina runs obliquely from the genital atrium to the region of the ovary. It opens into the genital atrium immediately ventral to the cirrus sac in the same transverse plane. The uterus develops as two transverse lobes on either side of the ovary, extending well beyond the excretory canals and behind the cirrus sac to the edges of the segment. In gravid segments the uterus appears as one large sac which fills the segment in which all the organs have degenerated except the cirrus sac and the large external seminal vesicle. Occasionally there are marginal uterine swellings similar to those described by Woodland. The eggs measure 23-25 μ in diameter and the onchospheres 12-15 μ , with small hooks measuring about 7 μ long.

As can be seen, the description of this species differs in certain respects from that of Woodland. We were not able to observe the detail of the cirrus sac described by him. The testes of our specimens are completely lateral to the excretory vessels (as described by Woodland) only in segments that are past their maturity. Baer 1933 in his description of specimens of this species also seems not to have found the testes lateral in position in young or immature segments. Again, the uterus of our specimens occasionally had lateral swellings, but they are not a constant feature, as they are in Woodland's specimens. However, these differences may in part be due to the state of contraction of the worms, and do not seem to justify the creation of a new species, so we prefer to record our specimens as *Hymenolepis phalacrocorax* (Woodland 1929).

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REDISCOVERY OF CTENERYTHRAEUS BERLESE 1918 (ACARINA, TROMBIDIIDAE), WITH REDESCRIPTION, AND ITS SYNONYMY WITH SPATHULATHROMBIUM WOMERSLEY 1945

BY R. V. SOUTHCOTT

Summary

The examination of a small collection of mites from New Caledonia has shown a species of Trombidiid mite answering to *Erythraeus* (*Ctenerythraeus*) *trombidioides* Berlese 1918 (from New Caledonia), which was placed by its author (and subsequent writers) in the family Erythraeidae. Although Berlese's type is at present inaccessible, the correspondence of the adult mite to Berlese's account (allowing for some obscurities in the latter's Latin description), both in descriptive and metric data, is excellent, and there appears no reason to doubt the identity. The mite also corresponds to *Spathulathrombium* Womersley 1945, which becomes a synonym of *Ctenerythraeus* Berlese 1918.

Ctenerythraeus trombidioides is redescribed from the new material, both adult and nymph. The species comes nearest to *Ctenerythraeus myloriensis* (Womersley 1945) from South Australia. Distinguishing characters between these two species are given. Apart from these two species the genus contains *C. southcotti* (Worn. 1934) (the genotype of *Spathulathrombium*), *C. queenslandiae* (Worn. 1942), *C. maximus* (Worn. 1945), and *C. fulgidus* (Worn. 1945). All except the genotype are from the Australian mainland.

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INTRODUCTION

In 1918 Berlese described *Erythraeus* (*Ctenerythraeus*) *trombidioides* as a new subgenus and species of Erythracid mite, of Trombidiid facies, from New Caledonia, where it had been collected by the expedition of "Sarrasin et Roux". Although listed by Baker and Wharton (1952) among the Erythracidae, up to the present no subsequent worker has made any contribution to our knowledge of that mite.

Berlese had stated that in *Ctenerythraeus* there was a comb-like row of spines along the dorsal border of the palpal tibia, as in the Trombidiidae ("*Trombidiurum more*"). Although such a comb is a common feature in many Trombidiid mites (particularly among the subfamily Microtrombidiinae Thor 1935), for an Erythracid the mite must have been very unusual indeed. In certain genera of Erythracid mites, e.g. the European *Erythraeus* Latreille 1806 and the Australian *Parerythraeus* Southcott 1946, there is a row of a small number of conical spines along the inferior border of the palpal tibia (and also the genu), but nothing similar had been observed along the dorsal border of the palp in any known Erythracid mite.

For some time the present writer has been attempting to clarify the systematics of the Erythraeidae, and in an attempt to clarify the status of *Ctenerythraeus* he wrote to Mr. L. J. Dumbleton, entomologist to the South Pacific Commission, asking for acarine material from New Caledonia. In the first batch of alcohol-preserved specimens from New Caledonia, from Mt. Mori, at 4000 ft., there were two reddish mites of Erythracid or Trombidiid facies. These corresponded to the genus *Spathulathrombium* Womersley 1945. One specimen was an adult, the other a nymph, but clearly the two specimens were of the same species. The spiky (longer) setae over the dorsum was, however, a feature seen in certain of the Erythraeidae as well as in some of the Trombidiidae.

On comparing these two mites with Berlese's Latin description of *Ctenerythraeus trombidioides* it was found that the latter corresponded in all major

details with the adult specimen, with a good correspondence to the metric data supplied by Berlese. Unfortunately, it is not possible for the writer to compare the specimens with Berlese's type, as no facilities are available at the institution which houses the Berlese collection in Florence.

As few modern students of the Acarina read Latin with any facility, and as in places Berlese's account is somewhat obscure, the following translation of Berlese's account is offered, with explanatory comment (the writer is indebted to Mr. J. L. Gough for aid with the translation):

"Subgenus *Ctenerythraeus* Berl. n. subgen. From (ex) the genus *Erythraeus*. The penultimate segment of the palpi with a great comb, armed, as in the Trombididae. The anterior legs with the tarsi dilated, but below rather projecting (prominent), as occurs in the Trombididae; the other tarsi elongate-cylindrical, of the same thickness as the tibiae (metatarsi, R.V.S.). Crista metopica very short, not produced further back than the line of the second coxae. Type *E. (C.) trombidioides* Berl.

"*Erythraeus (Ctenerythraeus) trombidioides* Berl. 1918 n. sp.—Ciunibar, elongately heart-shaped, the whole trunk densely clothed with red papillae, compressedly clavate, all of these being thickly aciculate (i.e. covered with little needles, R.V.S.), to 50μ long, between which, equally and densely scattered, are cylindrical setae, three or four times as long as the foregoing, i.e. $150-200\mu$ long, curved back in the shape of a bow, and finely needle-like. Crista metopica 300μ long. Eyes paired on both sides (the anterior the larger), placed a little above (i.e. before, R.V.S.) the level of the posterior area of the crista, and quite close to the crista. Palpi long and slender, the penultimate segment cylindrical, 120μ long, 30μ wide, provided with a most beautiful comb occupying the whole of the dorsum of the segment, nevertheless bent inwardly. The comb is composed of spines, about 25 in number, decreasing in thickness in order from the apical one, to which the palpal claw is adpressed, and (the apical one) scarcely feebler (than the claw). There are also on the inner side, basally, in this segment, 10 setae, longer and thinner, arranged in a transverse series which is close and parallel to the posterior margin of the segment. The most posterior segment, that is (sic) the tentaculum (pfemur, R.V.S.) is elongately almond-shaped, very much thinned out toward the apex and produced to the line of the base of the (?) foot (unguis) of the preceding segment; the whole provided with evenly scattered hairs, longer, thin. The skin of the palpi and legs (pedes) is provided with areolae, and not with papillae, as occurs in the trunk, but all segments of the legs are provided thickly with only the cylindrical setae, similar to those on the trunk, but smaller, and with other slender hairs of simple form, but very short. The anterior tarsi are about twice as thick as the tibiae (metatarsi, R.V.S.) and are nearly straight dorsally, even slightly concave, little heightened; ventrally strongly arched and prominent. Tarsal length 500μ , width 130μ . Tibia (metatarsus) 500μ long, 120μ wide. (Animal) 2500μ long, 1650μ wide. Leg I 2200μ long.

"Habitat in New Caledonia ('Prony'). One example, collected by 'Cll. Sarasin et Roux'."

The above account may be compared with the following description from two fresh specimens from New Caledonia, considered by the present writer to belong to the same species.

Redescription of Ctenerythraeus trombidioides (Berlese 1918)

Figs. 1-3

Adult (Figs. 1 A-C, 2) (from ACB 608): Colour (in alcohol) reddish. Body ovoid, 1965μ long to tip of mouth cone, 1250μ wide. The dorsum is provided with a crista which bears a single sensillary area, at its posterior end.

The sensillary area is typical of the Trombidiidae (see Fig. 2), pyriform, strongly chitinized, with each of the two sensillary setae set in a projecting boss. Sensillary setae about 220μ long, filiform, nude. Sensillary pits 43μ apart (distance between centres). The anterior end of the crista tapers to a blunt point, ending somewhat obscurely, but without any sign of a sensillary area. Total length of crista 395μ . Sensillary pits (centres of) 20μ ahead of posterior end of crista. Each sensillary boss is surrounded by a lanceolate group of reticulations, the axis of this reticular pattern lying obliquely forwards and medially.

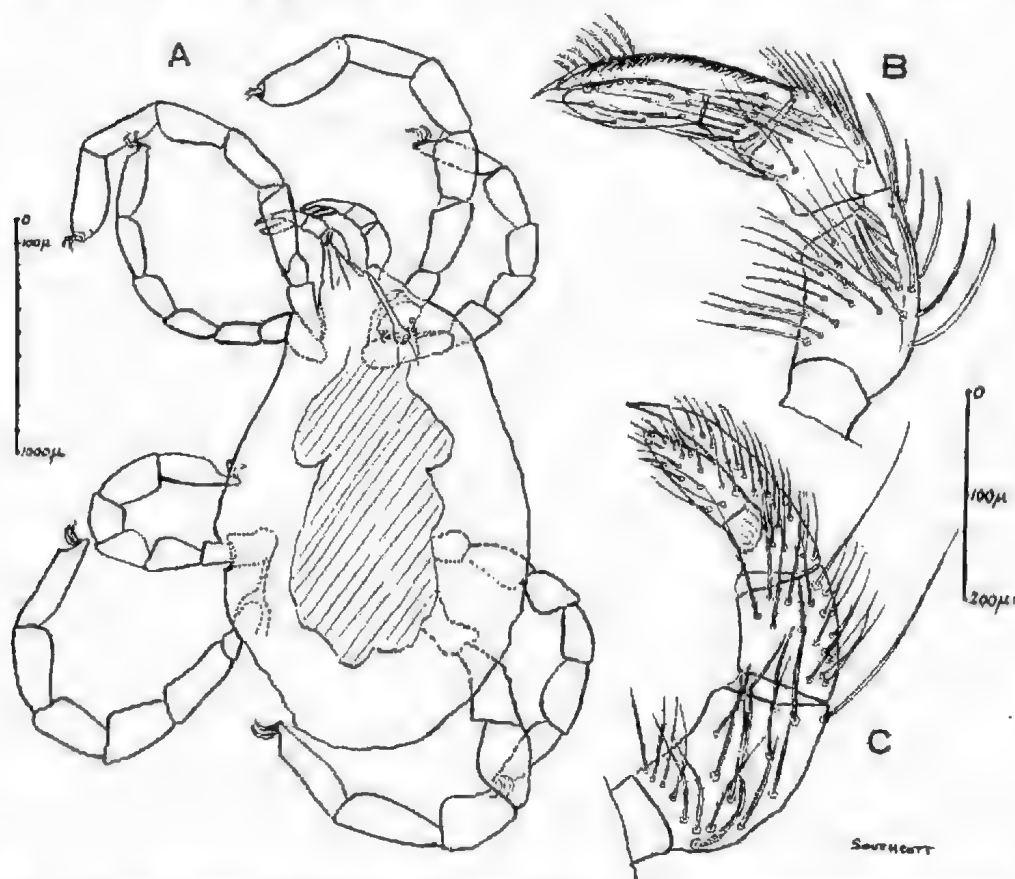


Fig. 1.—*Clencyrthraeus trombidioides* (Berlese, 1918). Adult. A, entire, mounted specimen, by transmitted light, with setae omitted (ventral structures stippled); B, inner face of right palp; C, outer face of right palp. (Figs. 1 B, C to scale on right.)

Eyes two on each side, on a distinct ocular shield. Anterior eye the larger, circular, 60μ across. Posterior eye circular, 36μ across, placed rather medial to the anterior eye.

Dorsum thickly clothed with setae of two distinct types, which are so dense as to obscure underlying structures, e.g. the eyes and the crista. The longer dorsal setae (macrosetae) are long, stiff, bent, needle-like or slightly lanceolate with adpressed minute rasp-like serrations, which latter are scarcely visible even along the edges of the setae; these setae arising from large setae bases, and are from 77 – 190μ long, increasing gradually in length towards the posterior part of the dorsum. The shorter setae (microsetae) are leaf-like, arched dorsally, and with their dorsal aspects covered with rows of strong projections, these being ciliations in the proximal half of the seta, and becoming blunter in the distal half, and often terminally the seta has two conical denticles;

ventrally there is a median keel, along each side of which is a row of long, strong-pointed ciliations; leaf-like setae 34-42 μ long. The seta bases of these smaller setae are weaker than in the long, sword-like setae. The setation of the body is so dense that it is, in the intact mounted specimen, difficult to see setae suitable for measuring the lengths; this being more so with the leaf-like setae than with the sword-like macrosetae.

The ventral surface is not available for measurement and description in the mounted specimen; this applies also to the genitalia.

The legs are for the most part clothed with setae similar to the sword-like setae of the trunk, but these setae rather more slender, and on the dorsal surfaces of the legs, more curved. In fact, on the dorsal surfaces of the legs these setae are thicker, blunted at the tip, and not quite smooth in their contour, giving the impression of having faint adpressed serrations. This appearance is also seen on the other setae. The thicker of these setae have a faint suggestion of a keel, and down each side of this keel is a series of fine-pointed ciliations. Among these setae are smaller, more slender, simple, curved spiniform setae, which are present also on the other segments, particularly on the genu and metatarsus (tibia). On the end of each tarsus is a pit into which the tarsal claws can be folded back (the dorsoterminal fossa). Tarsal claws II, III and IV strong; on I weaker. Tarsus I appears rather inflated, particularly inferiorly, and is covered with short, tapering, ciliated setae, interspersed among which are numerous fine-pointed, simple spiniform setae, as well as a few longer setae, the latter spiniform with faint adpressed rasp-like roughenings, and about twice as long as the other setae. The setae on tarsus II are almost all ciliated, somewhat coarser than on I. Legs robust. Tarsus I 420 μ long by 175 μ high; tarsus II 338 μ long by 104 μ high, tarsus III 370 μ long by 112 μ high, IV 478 μ long by 125 μ high. Metatarsus I 360 μ long, II 280 μ , III 320 μ , IV 450 μ .

The cheliceral fangs are typically Trombidiid, curved, convex downwards, pointed for grasping and piercing, articulated (hinged) normally. The fang about 56 μ long, with a faint row of dorsal denticles, similar to that of the nymph (q.v.—those in the adult are a little obscured in the preparation).

The palpi are rather slender, and provided with setae as figured. The palpal trochanter nude. Palpal femur dorsally and laterally with long, strong, blunted setae with adnate ciliations, to 135 μ long. At the distal end of the dorsum of the palpal femur there is a long outstanding spiniform seta, 217 μ long (which is very faintly indented, indicating its origin as a modified normal type seta), clearly of a tactile function. The superior edge of the palpal femur (and genu) tends to be rolled inwards, at least in the mounted preparation. The medial and inferior surfaces of the palpal femur with long-pointed, lightly ciliated setae, to 112 μ long. Palpal genu dorsally provided with a group of stiff spiniform setae along its more distal part, about 20 in number, to 76 μ long, arising along the dorsal border. Elsewhere the palpal genu is provided with pointed somewhat more flaccid ciliated setae, to 80 μ long. At the distal end of its dorsum, rather laterally, is a long outstanding tactile spine, as in the palpal femur, 173 μ long. The palpal tibia is also provided proximally on its medial surface with an irregular row of rather stiff spiniform setae, 11 in number, roughly parallel to the posteromedial border of the tibia; elsewhere the medial surface of the palpal tibia is bare of setae. Along the dorsal border of the palpal tibia is a pectinate row of 27 stiff, blunted spines, bent inwards (medially), and overlapping each other in medial view, so much so they are difficult to count (see Fig. 1 B). In the middle part the free edge of the spines lifts up to reveal the bases of the spines. The terminal (most anterior) spine is the largest, and is 30 μ long; it is alongside the palpal tibial claw. Palpal tibia with a large normal claw. The palpal tibia carries no thick external spine (a feature of some Trombidiidae).

Palpal tarsus tapering, with many setae, some tapering and spiniform, some ciliated along one side (see Fig. 1 B). On the dorsal border of the palpal tarsus is a linear group of setae, long, ciliated along one side, forming almost a pectinate array; these are clearly tactile in function, to aid the grasping of the palpus.

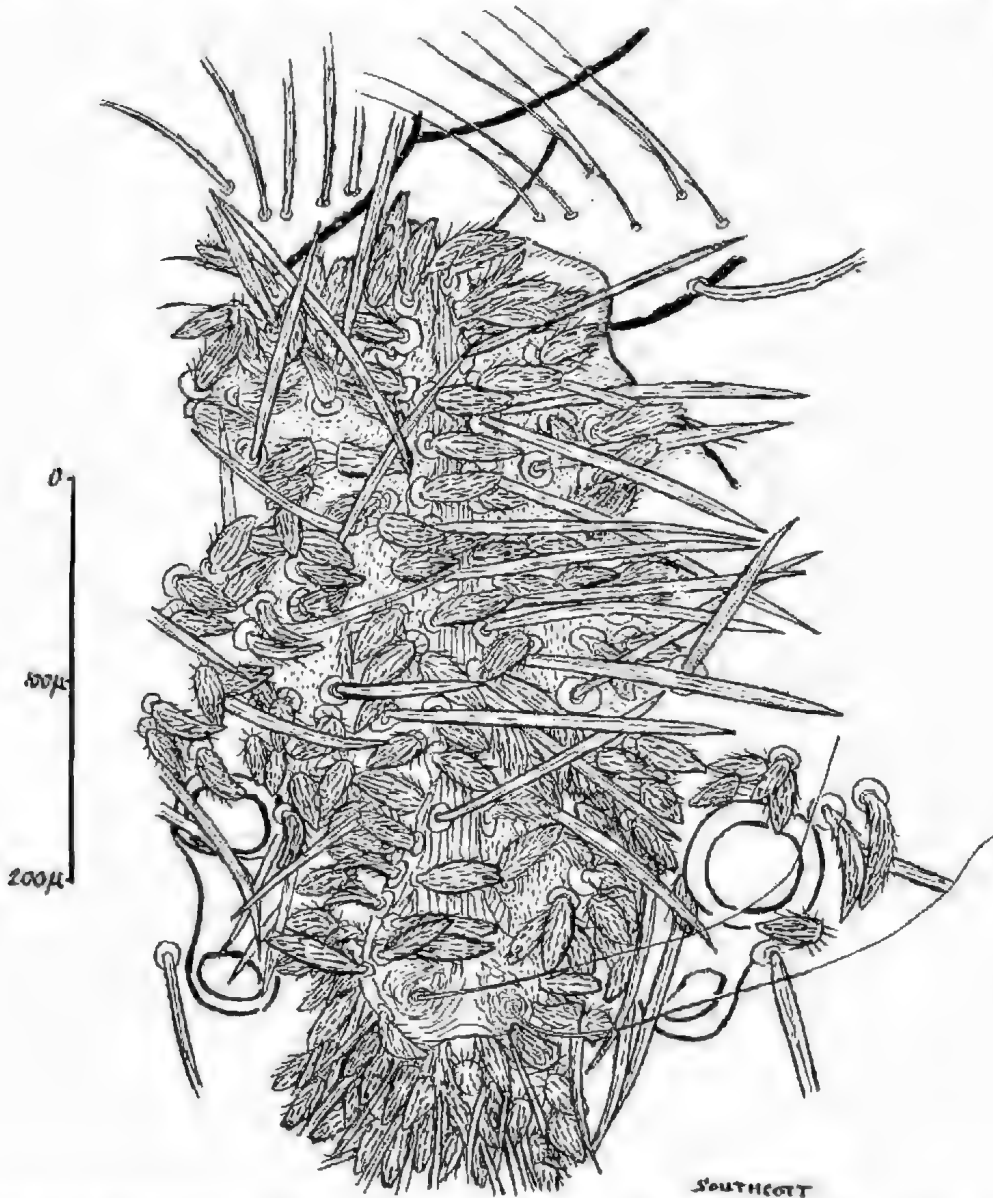


Fig. 2.—*Ctenerythraeus trombidioides* (Berlese, 1918). Adult. Crista and eyes, and part of dorsum and palpi, to show setation.

Description of Nymph

Fig. 3

Colour (in alcohol) reddish. Body ovoid, the mounted specimen (ACB 609) being 1175μ long to the tip of the rostrum (mouth cone), and 675μ wide at its widest part. The animal presents a rather bristly appearance from the

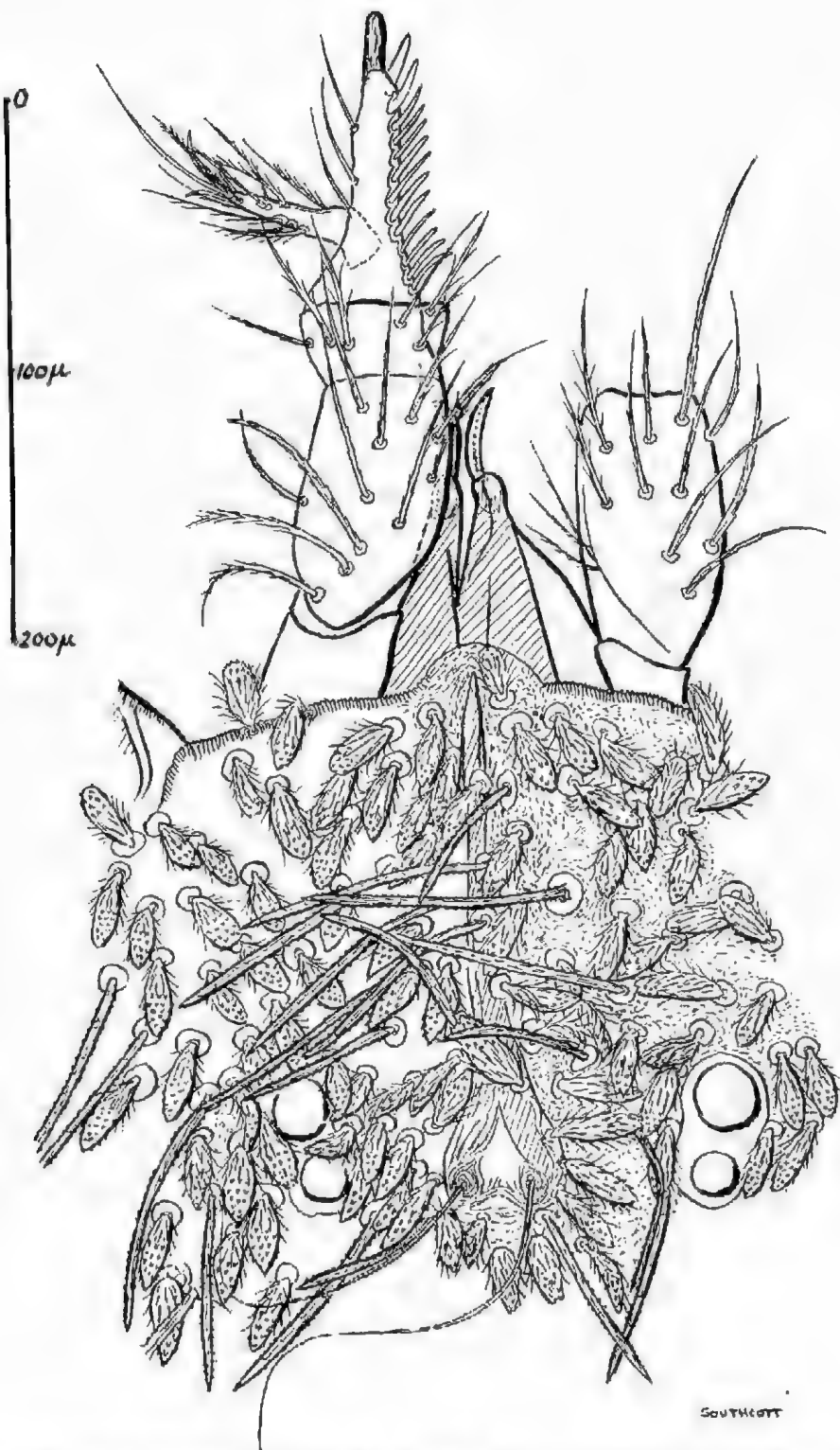


Fig. 3.—*Ctenerythraeus trombidoides* (Berlese, 1918). Nymph. Part of propodosoma and adjacent structures.

profusion of the outstanding longer dorsal setae, which, however, are rather less numerous than in the adult.

Crista as in the adult, with a single sensillary area, forming an expanded posterior bulb 46μ across. Centres of sensillae bases 22μ apart. Sensillae filiform, nude, 173μ long. Anterior end of crista pointed, ending a little indistinctly behind a dome-like projection (which evidently corresponds to the tectum of e.g. the *Leeuwenhoekinae*, but carries no setae), overhanging the cheliceræ bases (see Fig. 2). Total length of crista 188μ . Sensillae bases 15μ in front of posterior end of posterior sensillary area. The reticular patterning around the sensillae bases, which is so prominent a feature in the adult, is only very slight in the nymph.

Eyes as in the adult, $2 + 2$, each lateral pair on a distinct obliquely placed ocular shield, sessile. Anterior eye 21μ across, posterior 14μ across.

Dorsum of body thickly clothed with two types of setae, as in the adult, but with the setae less chitinated, and somewhat sparser. Longer setae $53-146\mu$ long; the shorter leaf-like setae $30-39\mu$ long, pretty uniform, with blunt points over their distal half, ciliated in the proximal half and along the lateral edges, the seta somewhat flattened, though with a curved dorsum. Both types of seta arise from large seta bases, as in the adult.

The ventral surface of the body is provided similarly with two types of setae, the one spiniform-lanceolate and the other shorter and leaf-like, as in the dorsum, but in each case the setae are rather weaker. Genital aperture 91μ long, with the usual two pairs of nymphal genital suckers.

Legs similar to the adult, but a little more slender, I 1020μ long, II 760μ , III 805μ , IV 1095μ (all lengths including coxae but exclusive of tarsal claws). The setation of the legs is similar to that of the adult, there being bristle-like or lightly ciliated setae, the latter pointed or blunted. No leaf-like setae on the legs. Claws on legs as in the adult. Tarsus I rather swollen inferiorly, 230μ long by 94μ high. Other tarsi cylindrical, II 183μ long by 46μ high, III $197\mu \times 45\mu$, IV $237\mu \times 45\mu$. Metatarsus (tibia) I 151μ long, II 115μ , III 135μ , IV 205μ .

Cheliceral fangs normal for the *Trombididae*, and are similar to those of the adult. The movable chela (fang) 45μ long, with a dorsal row of 10 minute denticles, increasing in size posteriorly, the anterior very small, the posterior pointing back in saw-teeth.

Palpi as figured, similar to the adult, but less heavily chitinated (see Fig. 3). The setation of the palp is similar to the adult, but the setae tend to be more pointed (see Fig. 3). Palpal tibia carries 13 stout spines along its dorsomedial border; the anterior spines almost straight; the spines are directed anteromedially, and are almost parallel, except that the more posterior spines tend to be a little retroflexed and spreading. The dorsal edge of the palpal tibia is rolled over to carry these spines. The anteriormost spine the stoutest, 26μ long, and is alongside the tibial claw (Fig. 3 shows the comb more clearly than does Fig. 1 B for the adult). Palpal tibial claw stout, 38μ long.

Palpal tarsus as figured (Fig. 3), slender, with numerous setae, ciliated generally or unilaterally; one solenoidal (striate) seta present, arising about halfway along the tarsus as figured; terminally the tarsus has a group of curved spiniform setae, the terminal the longest, and 66μ long.

Locality. The two specimens examined are: adult (ACB 608) and nymph (ACB 609), from Mt. Mori, New Caledonia, at 4000 feet, among leaf mould, March 1955, collected by L. J. Dumbleton; in author's collection.

The Systematic Position of Ctenerythraeus

As indicated above, a comparison of the two fresh specimens received from Mr. Dumbleton reveals no significant point of difference from Berlese's account.

Apart from some of the minor description of the palpi, where Berlese's account is obscure (commented on above) the correspondence is obviously good. The writer therefore sees no reason to doubt that *Ctenerythraeus* Berlese 1918 is the same as *Spathulathrombium* Womersley 1945. Womersley's (1945) definition of *Spathulathrombium* reads as follows:

"As in *Echinothrombium*^{*} with the larger dorsal setae long and spine-like, but the smaller setae spathulate with ciliations or setules. The posterior arm of the crista very evanescent, almost invisible, so that the sensillary area appears to be posterior. In all known species the palpal tibia without any external spine, distal portion of tibia slender, almost twice as long as basal part.

"Genotype *M. (icrotrombidium) southcotti* Wom. 1934".

The specimens described in the present paper answer to Womersley's definition of *Spathulathrombium*.

Apart from the genotype (*C. trombidioides* (Berl. 1918)) the genus *Ctenerythraeus* now contains *C. southcotti* (Wom. 1934) (the genotype of *Spathulathrombium* Wom. 1945), *C. maximus* (Wom. 1945), *C. queenslandiae* (Wom. 1942), *C. fulgidus* (Wom. 1945), and *C. myloriensis* (Wom. 1945). All these species of Womersley are Australian. *C. southcotti* was captured by the writer near Karkar, National Park, Belair, South Australia, 1st February 1934 (and not as shown by Womersley (1934) (1945)). In 1945 Womersley described "*S. queenslandiae* n. sp." from Gympie, Queensland, April 27th 1940, collected by D. J. W. Smith, overlooking the fact that he had described this species as *Echinothrombium queenslandiae* in 1942. *C. fulgidus* (Wom. 1945) came from Robe, South Australia, 13th October 1943 (coll. H. Womersley), and *C. myloriensis* (Wom. 1945) from Mylor, South Australia, 14th September 1935 (coll. H. Womersley). Of these species *C. trombidioides* (Berl. 1918) comes nearest to *C. myloriensis*. The differences between the adults of these two species can be seen from the tabular data below.

	Body	Macrosetae length	Microsetae length	Tarsus I	Meta-tarsus I	Sensillary bases
<i>C. myloriensis</i> (Wom. 1945) (after Womersley 1945)	L. 2.55mm W 1.35mm	to 120 μ	56 μ	L. 285 μ W 93 μ	185 μ	21 μ
<i>C. trombidioides</i> (Berl. 1918) (ACB 608)	L. 1.97mm W 1.25mm	77-190 μ	34-12 μ	L. 120 μ W 175 μ	350 μ	43 μ
<i>C. trombidioides</i> (Berl. 1918), type specimen (after Berlese 1918)	L. 2.8mm W 1.65mm	150-200 μ	to 50 μ	L. 500 μ W 120 μ	500 μ	

As can be seen from the foregoing table, the easiest character by which the two species may be separated is on the length of the macrosetae: in *C. myloriensis* they are to 120 μ long (according to Womersley 1945); in *C. trombidioides* they are longer, to 200 μ .

* The genus *Echinothrombium* Womersley 1937 (with type *Otonia spinosa* Canestrini 1855 from Europe (not 1877, as Womersley stated in 1937 and 1945)) is the adult of the genus *Ettmülleria* Oudemans 1911, the latter genus therefore having priority. This opinion by the writer is based on his rearing on a number of occasions of the larva of the Australian species *Microtrombidium willungae* Hirst 1931 = *Echinothrombium willungae* (Womersley 1945) (adult forms) = *Ettmülleria* cf. *obscura* Womersley 1936 (larval). This species should therefore be re-named *Ettmülleria willungae* (Hirst 1931). These experiments will be described in a later paper.

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A NEW FRANKENIA FROM SOUTH AUSTRALIA

BY R. MELVILLE

Summary

A NEW FRANKENIA FROM SOUTH AUSTRALIA

by R. MELVILLE*

[Read 9 August 1956]

Among a small collection of *Frankenias* received in 1953 from Mr. E. H. Ising, two plants were found that represented an undescribed species. These came from Evelyn Downs, about 90 miles south-west of Oodnadatta, South Australia. As the original specimens were somewhat fragmentary, a request for further material was made, and it is a pleasure to acknowledge the ready co-operation of Mr. Ising in obtaining the fine suite of specimens from the same area on which the accompanying description is based.

Frankenia plicata Melville, sp. nov.; *F. densae* Summerhayes affinis sed foliis angustioribus, glabris, marginibus contingentibus revolutis, calycibus eleganter plicatis et seminibus glabris differt.

Caules erecti vel prostrati, multiramosi, ad 25 cm. longi, internodiis 0.5-3.7.6 mm. longis, pilis brevibus erectis dense induti. Folia linearia obtusa vel subacuta, 1.5-4.0-6.0 mm. longa, supra glandulipunctata, glabra vel interdum hispidula, marginibus contingentibus revolutis; petiolus 0.6-1.5 mm. longus. Flores solitarii, bracteolis foliis similibus. Calyx oblanceolatus vel fusiformis, 5.5-7.0-8.0 mm. longus, 5-plicatus, liris applanatis glabris et sulcis pubescentibus; lobi acuti, marginibus scariosis breviter ciliatis, apicibus solidis. Petala 5, pallide carnea vel fere alba, 7.9-11 mm. longa, cuneata, apicibus sinuato-dentatis; unguis squama anguste elliptica acuta instructus. Stamina 6, 3 exteriora filamentis applanatis linearibus circa 6 mm. longis, 3 interiora filamentis linearilanceolatis plicatis circa 7.5 mm. longis. Ovarium 2.0-2.5 mm. longum, trimnerum, stylus circa 8 mm. longus, ramis stigmatiferis 3, circa 1 mm. longis; stigmata subcapitata vel clavata; ovula 3-4 rare-6, funiculis superne refractis, basi ad valvas \pm adnatis. Capsula 3.5-4.0 mm. longa; semina 1-4, circa 1.7 mm. longa (imbibita), glabra, ellipsoidea, leviter applanata.

South Australia: Evelyn Downs, 90 ml. S.W. of Oodnadatta, E. H. Ising no. 3610, 22.9.1953, Holotype in Herb. Kew. The following numbers are from the same collector and locality: E.41, Oct. 1950; 3582, 10.10.1952; 3601, 3602, 3603, 3605, 3611, 3612, 12.9.1953; 3604, 3606, 3609, 22.9.1953; 3607, 3608, 21.10.1953; 3768, 23.10.1954; 3769, 28.10.1955.

Stems to 25 cm. long erect or prostrated, densely branched, densely short pubescent with straight hairs, internodes 0.5-3.0-7.0 mm. long. Leaves linear obtuse to subacute, 1.5-4.0-6.0 mm. long, grey green glabrous and gland dotted above or sometimes hispidulous, tightly enrolled and hiding the midrib below, petiolate, basal sheath ciliate. Flowers solitary near the tips of the branches, bracteoles like the leaves. Calyx oblanceolate, to fusiform, 5.5-7.8 mm. long, plicate into 5 glabrous + flat-topped ridges with sides of the grooves puberulent, lobes acute with a scarious short ciliate margin and solid tip. Petals 5, 7.9-11 mm. long pale pink to nearly white, cuneate with a sinuate-dentate apex and the claw with a narrow elliptic acute scale about half as long as the petals. Stamens 6, 3 outer with linear flattened filaments about 6 mm. long, 3 inner with linear lanceolate, flattened plicate filaments about 7½ mm. long, anthers red. Ovary about 2.0-2.5 mm. long, trimcrous, style about 8 mm. long with 3 stigmatic arms about 1 mm. long, stigmas sub-capitate to clavate, ovules 3-4

* Royal Botanic Gardens, Kew, England.

or rarely up to 6 pendulous on long funicles, parietal from shortly above the base. Capsule 3.5-4.0 mm. long, seeds usually 1-4, about 1.7 mm. long (imbibed), smooth, ellipsoid, slightly flattened with an obscure rounded ridge along one margin (raphe) ending in a small rounded protuberance at the micropylar end.

The plants are usually erect but are sometimes laid prostrate by the rush of water and soil in the small hillside channels in which they grow. They are restricted to such situations that take the first run-off after rains.

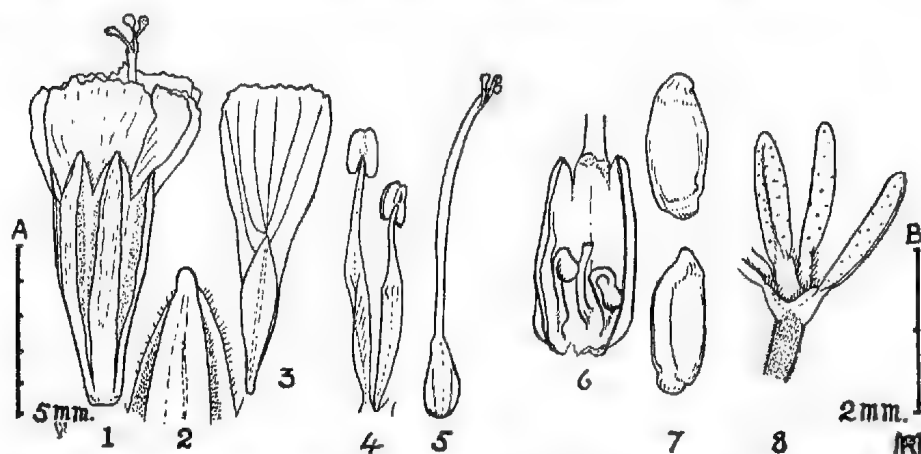


Fig. 1.—*Frankenia plicata* Melville. 1, entire flower; 2, tip of calyx lobe; 3, petal; 4, pair of stamens, outer the shorter; 5, ovary; 6, ovary dissected, one ovule removed; 7, seed, two views; 8, group of leaves. 1, 3-5, 8, scale A; 2, 6-7, scale B. All from the holotype.

THE GENUS ACOMATACARUS (ACARINA : TROMBICULIDAE)
I. DESCRIPTION OF THREE NEW SPECIES FROM TRINITY BAY,
NORTH QUEENSLAND

BY R. V. SOUTHCOTT

Summary

Three new species of the genus *Acomatacarus* Ewing 1942 are described from the Trinity Bay area of north Queensland -*A. cooki* n. sp., *A. mathewi* n. sp., and *A. langani* n. sp. These are compared with the previously known Australian species.

Some comment is made on tracheation within the genus. In *A. cooki* n. sp. and *A. langani* n. sp. the tracheal system does not differ from certain previously described species. In *A. mathewi* n. sp. there is a more defined supracoxal loop above coxa I, and also there appears to be a collection of tracheae in the posterior gnathosomal region, in the midline.

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[Read 13 September 1956]

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INTRODUCTION

In a study of the Trombiculid and other mite fauna collected by the writer in the vicinity of a scrub typhus focus at Dead Man's Gully, Trinity Bay, north Queensland, in 1943 and 1944 (see Southcott, 1947), a small number of mites of the genus *Acomatacarus* Ewing 1942 (Trombiculidae) was found. These have been found to belong to three species, described as new in the present paper, and named *A. cooki* n. sp., *A. mathewi* n. sp., and *A. langani* n. sp., after three students of the epidemiology of scrub typhus in north Queensland.

At the present time there is no evidence that this genus of Trombiculid mites is of any significance in the epidemiology of the typhus diseases in Australia. The only reference known to the writer suggesting a connexion between *Acomatacarus* and a Rickettsial infection is a report by Chumakov (1955) that *Coxiella* (*Rickettsia*) *burneti* (the causative agent of Q fever) has been isolated in central Asia from "mites of the genera *Leeuwenhoekia* and *Dermanyssus*". That article has been seen by the present writer only in abstract form. Presumably by the term "*Leeuwenhoekia*" the more restricted sense of the genus *Acomatacarus* Ewing 1942 is intended, as at the present time *Leeuwenhoekia* Oudemans 1910 has been restricted by most workers to the genotype, *L. verduni* (Oudemans 1910) from Brazil, and the genus *Acomatacarus* covers species ranging from North America, Europe, Africa, Asia and Australasia (Wharton and Fuller, 1952).

DESCRIPTION OF THREE NEW SPECIES

(i) *Acomatacarus cooki* n. sp.

Figs. 1, 2

Description of Larva (from Type specimen ACB 199A): Colour not recorded. Length of idiosoma (moderately engorged specimen) 645μ , width 470μ (animal 730μ long to tip of mouthparts, the chelae). The shape of the moderately engorged Type specimen is typical of the larval Trombiculidae in a moderate state of engorgement, a constricted ovoid.

Dorsal scutum moderately broad. AM setae slightly tapering, 45μ long, with barbed ciliations, and with bases 13μ apart (AMB). AL setae similar to AM, 55μ long; PL setae similar, 72μ long. Sensillae (from ACB 199B, paratype; missing in Type specimen) moderately ciliated, there being 10-12 ciliations, in

the distal half of the seta, seta 53 μ long. The standard data for the Type and paratype specimen as follow:

	AW	PW	SB	ASB	PSB	SD	A-P	AM	AL	PL	AMB	Sens.	PW/SD
ACB 199A Type	78	89	27	36	25	61	26	45	55	72	13	—	1.44
ACB 199B Para-type	70	87	29	34	—	—	28	45	55	72	11	53	—

Dorsal abdominal setae similar to the PL scutal setae, 41-49 μ long, arranged approximately 2 9 6 7 10 10 8 4 3, total 59,

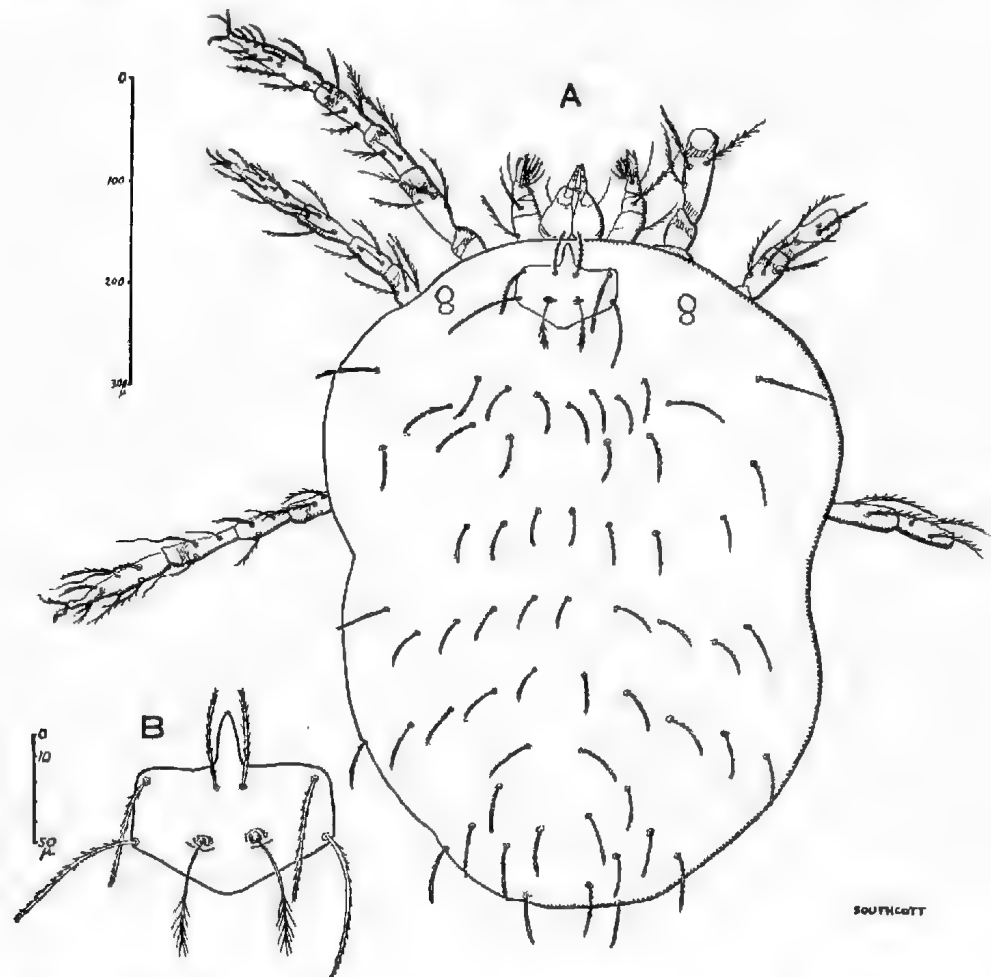


Fig. 1.—*Acomatacarus cooki* n. sp., larva, A, dorsal view, partially engorged; B, dorsal scutum. (From the Type specimen, except the sensillae.)

Eyes 2 + 2, well clear of the dorsal scutum. Anterior eye 20 μ across, posterior 14 μ across.

Ventral surface: a pair of tapering pointed strongly ciliated setae between coxae III, 36 μ long. Behind coxae III are numerous tapering pointed strongly

ciliated setae, arranged as figured; the anterior short, $27\text{--}31\mu$ long, the posterior longer, to 46μ long.

Tracheal system as figured.

The legs are all 6-segmented. Leg I 440μ long, II 370μ , III 450μ (all lengths inclusive of coxae and claws). Chaetotaxy of legs as figured. Coxa I with 2 setae, tapering, pointed, strongly ciliated, situated as figured, the lateral

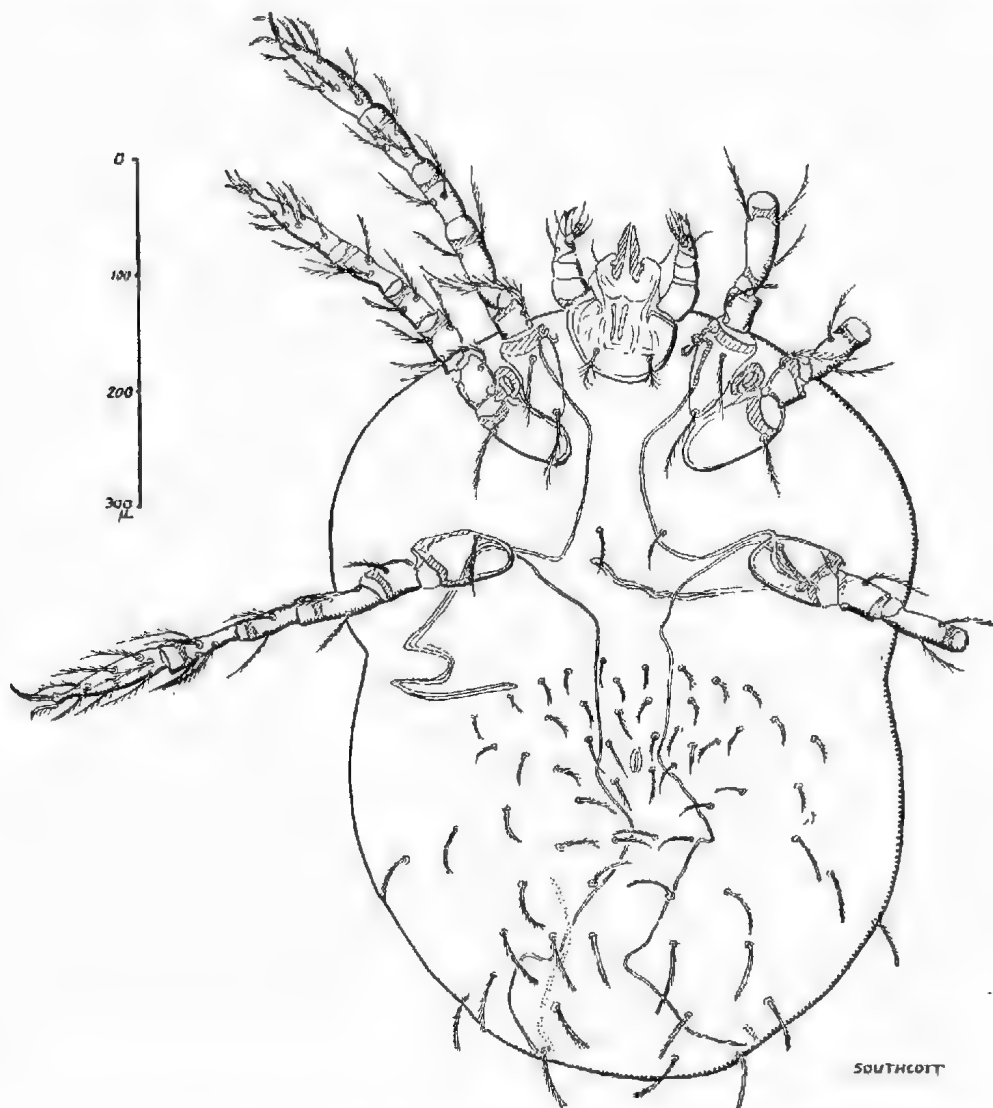


Fig. 2.—*Acomatacurus cooki* n. sp., larva. Ventral view, partially engorged, showing external morphology, and the tracheal system. Posteriorly the part of the trachea nearer the dorsum is shown in stipple. (From the Type specimen.)

seta 55μ long, the medial seta 55μ long. Coxa II with a similar seta 61μ ; III seta similar 55μ . Each trochanter with one seta. Tarsus I 110μ long (to origin of claws) by 34μ high; metatarsus I 68μ long. Tarsus III with 1 (?2) whip-like setae; metatarsus III with 2 whip-like setae. Claws and empodium of the tarsi typical, falciform, slender, ciliated.

Capitulum as figured. Chelicerae normal, with 4 ventral bent-over denticles (retention denticles), and dorsally with about 5 saw teeth, the first 3 of these minute, increasing in size posteriorad. Cheliceral fang 42μ long. Galeal seta 34μ long, nearly nude, with only a few small ciliations. Palpal setal formula (Audy's notation) B, B, B N(b) N(b). Dorsal palpal tibial seta strong, curved, strongly ciliated, 28μ long. Palpal tibial claw with two weaker dorsal accessory prongs; main prong 27μ long.

Locality: Two specimens, type specimen ACB 199A and paratype specimen ACB 199B, parasitic in the ear of a domestic cat, in the "posterior pinna pocket" placed at the rear of the edge of the pinna, the animal being a pet in a military camp near Palm Beach, Trinity Bay, north Queensland (map reference 612878 (Cairns 1: 63,360)), 20th December, 1943, along with a small Ixodid tick ACC 159 (unidentified). Specimens collected by the writer; in writer's collection.

The locality concerned was a camp-site about a mile north of the scrub typhus focus at map reference 614863 (Cairns 1: 63,360); that camp-site was, in the writer's experience, free of the disease.

Biology of the Mite: An attempt was made by the writer to rear these two mites to the nymphal stage, using the technique recorded by the writer (1946) for the Erythraeid mites, but with the atmosphere rather damper. The attempt failed, as the technique required had not been mastered. Since then the writer has reared larvae of another species of *Acomatacarus*—*A. adelaideae* (Wom. 1944)—to nymphs, using a customary wet tube and paper rearing technique (these experiments will be described elsewhere). Quite wet conditions are necessary for success.

Comment on Tracheation: The system of tracheation shown for this species is very similar to that recorded by Brennan (1949) for *A. arizonensis* Ewing 1942 from North America; see the comment under the succeeding species.

Systematic Position: This species comes nearest to *A. longipes* Wom. 1945 from New Guinea, but has significantly smaller SD, A-P and AL, by which it may be separated if Womersley's (1945) key is used. Both *A. cooki* n. sp. and *A. longipes* have two whip-like setae on metatarsus III.

Nomenclature: This species is named in honour of Dr. C. E. Cook, whose epidemiological researches were responsible for defining the focus of scrub typhus at Dead Man's Gully, Trinity Bay.

(ii) *Acomatacarus mathewi* n. sp.

Figs. 3, 4.

Description of Larva (from type specimen ACB 607): Colour red. Length of idiosoma (unengorged) 190μ (the animal is 270μ long from tip of chelae to posterior pole of body), width 175μ . Shape roughly globular.

Dorsal scutum of the typical shape for the genus. AM setae tapering, ciliated (barbed), 29μ long, with bases 9μ apart (= AMB); PL setae similar, with adpressed ciliations, 34μ long; AL setae similar but more prominently ciliated, 30μ long. Sensillae delicately ciliated distally, with about 9 ciliations, and about 69μ long. The standard data of the specimens available are:

Number	AW	PW	SB	ASB	PSB	SD	A-P	AM	AL	PL	AMB	Sens.	PW/SD
ACB 607 Type	62	83	26	32	21	53	26	29	30	34	9	69	1.56
ACB 189A Para-type	59	72	23	29	23	52	25	29	26	32	8	62	1.39
ACB 189B Para-type	63	73	24	26	29	55	26	26	26	29	8	—	1.33

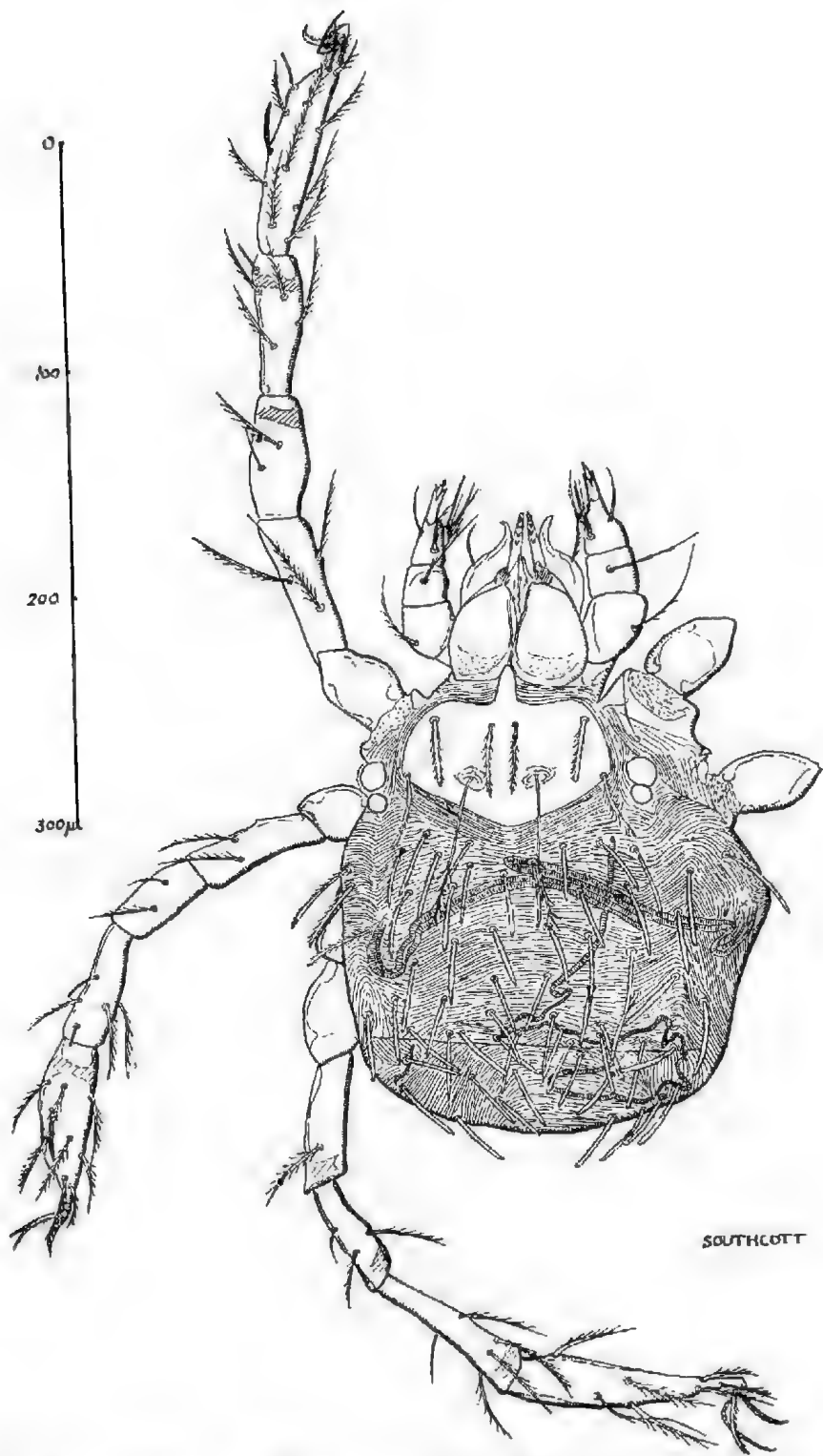


Fig. 3.—*Acomatacarus matheui* n. sp., larva. Dorsal view, unengorged. The tracheae nearer the dorsum are shown; these connecting at the points marked "X" to those nearer the venter, shown in Fig. 4, q.v. (From the Type specimen.)

Dorsal abdominal setae lanceolate with adpressed ciliations, 29-32 μ long, numbering 58 in all, arranged somewhat irregularly in rows of up to 10.

Eyes 2 + 2, as figured; the anterior eye the larger, 19 μ across, posterior eye 18 μ across.

Ventral Surface: A pair of tapering, pointed, ciliated setae between coxae III, 31 μ long; behind coxae III are rows of similar setae, these becoming stronger posteriorly, 24-30 μ long, and about 40 in all.

Tracheal system as figured. This will be commented on further below.

The legs are all 6-segmented; I 350 μ long, II 340 μ , III 385 μ (all lengths including coxae and claws). Chaetotaxy of legs as figured. Coxa I with 2 setae, tapering, pointed, strongly ciliated, lateral 42 μ long, medial 40 μ long. Coxa II with a similar seta, 37 μ long, coxa III seta similar, 38 μ long. Each trochanter with a single seta, arising anteroventrally. Tarsus I 96 μ long (to origin of claws) by 26 μ high; metatarsus I 61 μ long. On tarsus III is one long whip-like seta, with a single ciliation as figured; no such seta on metatarsus III, only the normal spiniform seta being present. Claws of tarsi falciform, ciliated along their sides, empodium thinner, also lightly ciliated along its sides.

Capitulum as figured. Chelicerae normal, each blade with 5 mammillate recurved retention teeth on the inner (ventral) side, bent over dorsomedially; on the outer (dorsal) side of the blade are 3 hooked saw-teeth, decreasing in size anteriorly. Cheliceral blade about 44 μ long. Galeal seta pointed, with adpressed ciliations along the outer side, 26 μ long. Palpal setal formula B(b), B(b), B b b(?N). Dorsal palpal tibial seta rather slender, tapering, lightly ciliated, pointed, 22 μ long. Palpal tibial claw typical of genus, with two dorsal accessory teeth.

Localities: Type specimen ACB 607 collected free at Dead Man's Gully, Trinity Bay, north Queensland, 2nd January, 1944, at map reference 614863 (Cairns 1: 63,360) (the site of the scrub typhus focus indicted by C. E. Cook). Paratypes ACB 189 A and B, collected at Trinity Bay, map reference (same map) 6183, a military camp-site free of the disease, 29th November, 1943, parasitic in the left external auditory meatus of a small skink, *Lygosoma* (*Sphaenomorphus*) *spaldingi* (Number R58, R.V.S. = South Australian Museum Register Number R2953 (presented) — lizard identified by F. J. Mitchell, South Australian Museum). Specimens collected by writer; in writer's collection.

Comment on Tracheation: As the figures indicate, there appear to be some differences in the tracheal system of this species from e. g. *A. cooki*. In *A. mathewi* there is a loop of trachea overlying coxa I; this appears to be more defined in position than has hitherto been described in all, or nearly all, species of this genus. Thus nothing comparable is described or figured by André (1943 a, b) for *A. paradoxus* (Europe), or by Brennan (1949) for *A. arizonensis* (North America). Hoffmann (1948) figured a highly convoluted trachea for the Mexican *A. chiapanensis*, and also (1951) for another Mexican species, *A. bakeri*. In both of these Mexican species there is some tendency for a loop to form in the trachea above coxa I, but in neither case is it placed as far laterally as in *A. mathewi*.

In *A. mathewi* there also appears a collection of tracheae—a "gnathosomal nexus"—in the region below the AM scutal setae, i.e. above the posterior part of the gnathosoma (see figure), but owing to difficulty in resolution this is hard to define clearly.

Systematic Position: This species, like the preceding, comes nearest to *A. longipes* in Womersley's (1945) key. From the latter, however, *A. mathewi* differs in having a significantly smaller AW, PW, SD, AL and PL. In fact, the PL in *A. mathewi* are only half the length of those in *A. longipes*. Also, in *A. mathewi* the metatarsus (tibia) III lacks whip-like setae; in *A. longipes* there are two such.

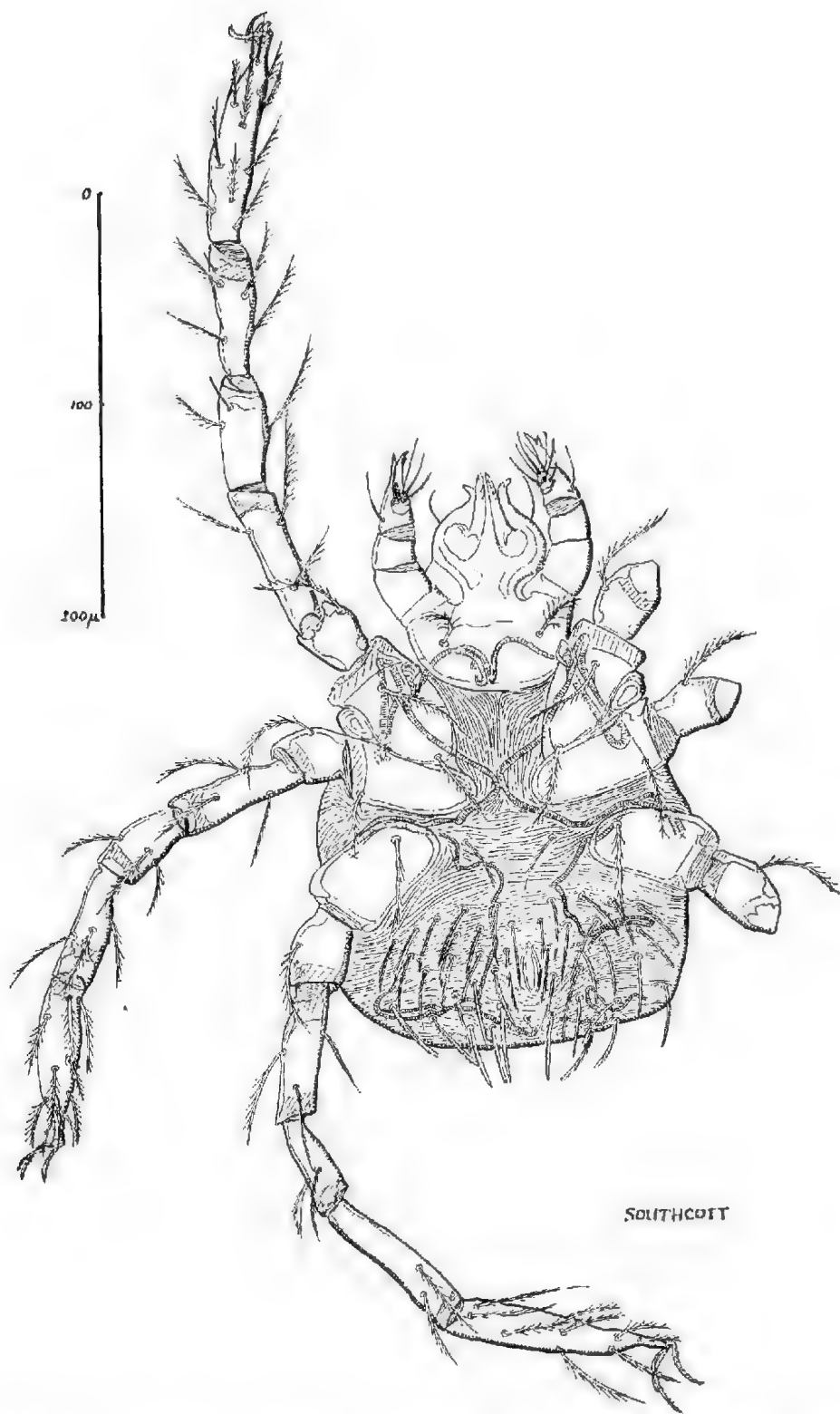


Fig. 4.—*Acomatacurus mathewi* n. sp., larva. Ventral view, unengorged. The tracheae nearer the venter are shown connecting at the points marked "X" to those more dorsal shown in Fig. 3, q.v. (From the Type specimen.)

Nomenclature: This species is named after H. Y. Mathew, a previous student of the epidemiology of scrub typhus in this area.

(iii) *Acomatacarus langani* n. sp.

Fig. 5

Description of Larva (from type specimen ACB 197 A6, somewhat damaged, but quite a distinct species). Colour not recorded. Length of idiosoma (partially engorged) approximately 400μ , width approximately 300μ .

The dorsal scutum small, with shape and structure as figured. AM scutal setae slightly tapering, blunted at tip, finely ciliated; AL and AM setae similar. Sensilla as figured, typical, with about 10 ciliations. The standard data as follow:

AW	PW	SB	ASB	PSB	SD	A-P	AM	AL	PL	AMB	Sens.	PW/SD
48	65	22	27	18	45	26	17	24	27	7	50	1.44

Dorsal abdominal setae tapering, blunted, ciliated, to 22μ long, the ciliations slight, bractate, pointed, a little outstanding; complete arrangement and total number of setae not available, but the setae are not unduly numerous, and are arranged in rows of mostly about 8-10.

Eyes 2 + 2; anterior 9μ across, posterior 8.5μ across. The eyes in the specimen are well clear of the shield (46μ away, indicative of moderate engorgement).

Ventral surface as figured. Setae between coxae III tapering, pointed, ciliated, 24μ long. Area behind coxae III not available for description.

Tracheal system as figured; this appears comparable to that of e.g. *A. cooki* and *A. arizonensis*.

Legs all 6-segmented. Leg I 250μ long, II 220μ , III 250μ (all lengths including coxae and claws). Chaetotaxy of legs as figured. Coxa I with 2 setae, tapering, pointed, ciliated, lateral 30μ long, medial 29μ long. Seta on coxa II similar, 22μ long; on III similar, 25μ long. Each trochanter with one seta. Tarsus I 67μ long (to origin of claws) by 18μ high. Metatarsus I 38μ long. Tarsus III with one whip-like seta; none on metatarsus III. Claws and empodium of tarsi normal.

Capitulum as figured. The cheliceral fang carries only a single ventro-external tooth, a little away from the edge (retention denticle), as figured. Dorsal edge of fang with the usual row of saw-teeth, increasing in size posteriorad, 8 in all. Galeal seta lightly ciliated, 15μ long. Palpal setal formula B, B, B b b. Dorsal palpal tibial seta moderately slender, curved, ciliated, 13μ long. Palpal tibial claw typical, with two dorsal accessory teeth.

Locality: Palm Beach, Trinity Bay, north Queensland, 18th December, 1943, parasitic in the external auditory meatus of a small skink, *Lygosoma* (*Leiolopisma*) *bicarinata* MacL. (No. R 67, R.V.S.= South Australian Museum Number R 2980 (donated) (identified by F. J. Mitchell, South Australian Museum)), along with several specimens of *Trombicula* (*Eutrombicula*) *tovelli* Wom. 1952 (ACB 197 A 1-5, B 1, 2) and a single female Mesostigmatid mite, *Haemolaelaps megaventralis* (Strandtmann 1947) (number ACC 160); the lizard also parasitized by 2 axillary *T. (E.) tovelli* (ACB 197 C, D). Specimens collected by the writer, in writer's collection.

Systematic Position: This species fits into caption (3) of Womersley's (1945) key, which includes *A. adelaideae* (Wom. 1944), *A. longipes* Wom. 1945, *A.*

australiensis (Hirst 1925), *A. nova-guinea* (Wom. 1944), and *A. barrinensis* Wom. 1945, but differs from these species, as well as from *A. cooki* n. sp. and *A. mathewi* n. sp. in the much smaller scutal dimensions. The presence of a single ventral denticle on the cheliceral fang of *A. langani* n. sp. is also possibly significant, and this character might repay further study from a systematic viewpoint; usually there appear to be about 5 denticles in this situation, where this has been studied.

Nomenclature: This species is named after A. M. Langan, who studied the epidemiology of scrub typhus in this area, in company with R. Y. Mathew.

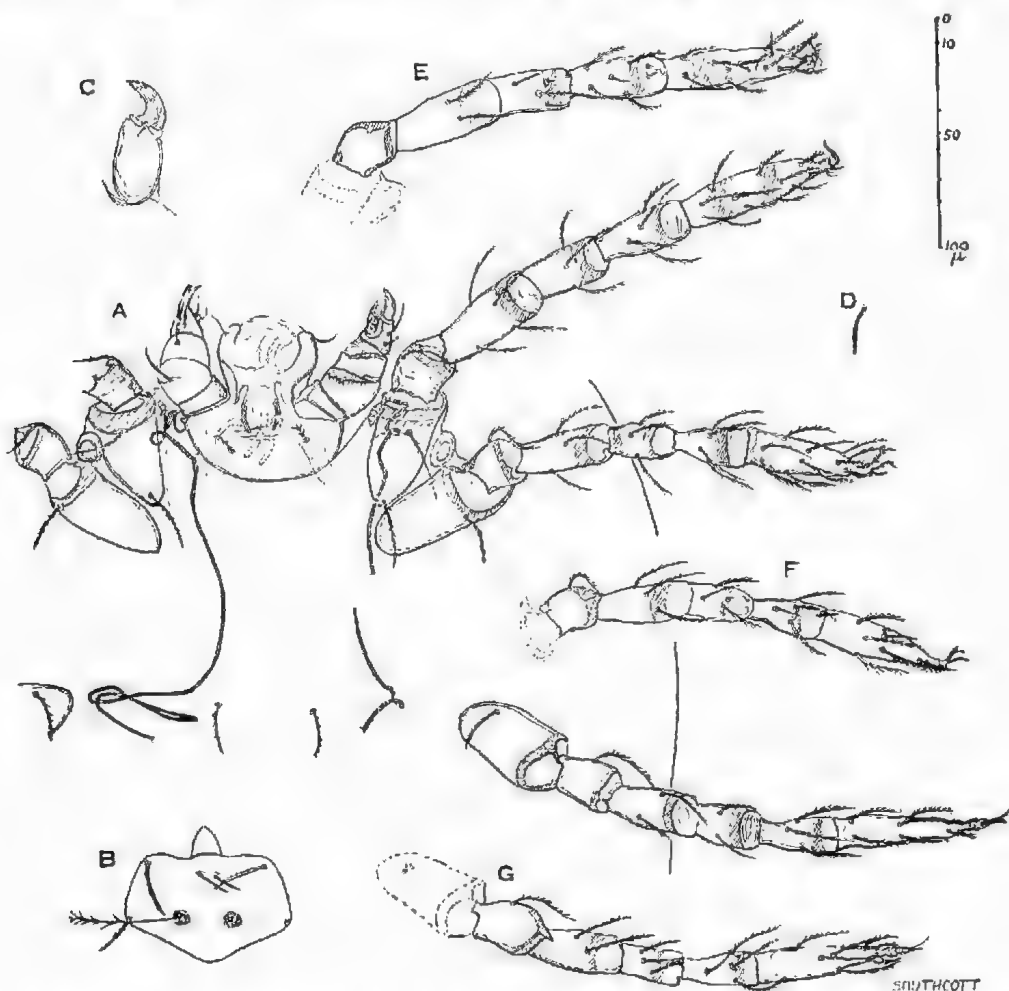


Fig. 5.—*Acomatacarus langani* n. sp., larva. A, ventral aspect, anteriorly, partially engorged, without chelicerae, and showing dorsal aspect of palp on left; B, dorsal scutum; C, right chelicera, detached, lateral aspect; D, dorsal abdominal seta; E, F, G, dorsal aspects of right legs I, II and III respectively; (All figures to scale shown; from the Type specimen.)

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THE GENUS NEOTROMBIDIUM (ACARINA : LEEUWENHOEKIIDAE)
II. FURTHER NOTES ON SYSTEMATICS, WITH A DESCRIPTION OF A
NEW SPECIES FROM NORTH QUEENSLAND

BY R. V. SOUTHCOTT

Summary

The systematics of the genus *Neotrombidium* Leonardi 1901 are reviewed critically.
The larval genera *Monunguis* Wharton 1938 and *Cockingsia* Womersley 1954 are synonyms.
A new species of the genus-*N. tridentifer* n. sp.-is described from north Queensland.
This is compared with the other species of the genus. Reference is made to the presence of
N. barringtonense Hirst 1928y the other Australian species, in north Queensland.
The biology of the larvae is referred to briefly; generally it appears that these are ectoparasites on
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[Read 13 September 1956]

SUMMARY

The systematics of the genus *Neotrombidium* Leonardi 1901 are reviewed critically. The larval genera *Monunguis* Wharton 1938 and *Cockingsia* Womersley 1954 are synonyms.

A new species of the genus—*N. tridentifer* n. sp.—is described from north Queensland. This is compared with the other species of the genus. Reference is made to the presence of *N. barringtonense* Hirst 1928, the other Australian species, in north Queensland.

The biology of the larvae is referred to briefly; generally it appears that these are ectoparasites on Coleoptera.

INTRODUCTION

In the first paper of this series the writer (1954) described the larva of *Neotrombidium barringtonense* Hirst 1928, obtained from eggs laid by adults in captivity. This correlation enabled the larval genus *Monunguis* Wharton 1938 to be synonymised with the adult *Neotrombidium* Leonardi 1901. Since then a further species of the genus has been reared in North America—*N. tricuspidum* Borland 1956—by Borland (1956), confirming the correlation of these two genera.

In a study of the acarine fauna collected by the writer in 1943 and 1944 in the vicinity of a focus of scrub typhus at Dead Man's Gully, Trinity Bay, north Queensland (see Southcott 1947), a few specimens of the postlarval stages of the genus *Neotrombidium* were found. Some of them belonged to *N. barringtonense*, and were referred to earlier by the writer (1954, *loc. cit.*). There were also, either on their own in the field, or in company with the preceding, a few specimens of an undescribed species of *Neotrombidium*. This, the second Australian species to be described, differs from all other known species in the structure of the dorsal setae. It is described below as *N. tridentifer* n. sp.

The opportunity will also be taken here of reviewing critically the knowledge of the systematics of the genus.

The Systematic Position of Neotrombidium

Womersley (1945, 1954) removed *Neotrombidium* from the subfamily Microtrombidiinae Thor 1935 to his family Leeuwenhoeekiidae. However, the systematic position of the genus is by no means generally agreed upon. Thus Borland (1956, *loc. cit.*), in the most recent article on the genus, stated, "There appears to be ample argument for placing *Neotrombidium* in any one of three families. Womersley (1954) placed the genus in the family Leeuwenhoeekiidae (Trombiculidae: Leeuwenhoeekiinae of authors). Wharton (1947) [1947b—R.V.S.] retained the genus in Trombidiidae but noted some affinities with Trombiculidae. *Neotrombidium* was placed in Trombidiidae by Baker and Wharton (1952), but in the key given by these authors it will fall into Trombiculidae on the character of the paired tectal setae." He continued by saying that he preferred to "leave the genus unassigned until the taxonomy of related genera be-

comes better known, and until family levels are drawn along more definite lines".

Womersley (1945) had founded the family *Leeuwenhoekidae* with the following comment: "In 1944 . . . the present writer erected the subfamily *Leeuwenhoekinae* for the larval genus *Leeuwenhoekia* Ouds. 1911, on the discovery of a true stigmal opening situated on each side between coxae I and the gnathosoma, from which tracheal tubes ramify* through the body. In this feature the species of *Leeuwenhoekia* s. l. differ from the other genera of the *Trombiculidae*".

André (1943a, b) had independently and earlier described the stigmal openings and tracheae in a species described from Europe as *Leeuwenhoekia paradoxa* André 1943. These reports, however, were not available to Womersley at the time.

Wharton (1947a) erected the subfamily *Apoloniinae* for the genera *Apolonia* Torres and Braga 1938 and *Womersia* Wharton 1947. Although Wharton recorded the presence of stigmata and tracheae in the *Apoloniinae*, he considered that within the *Trombiculidae* the leg segmentation was of greater significance from a systematic point of view, and preferred to use the presence or absence of stigmata and tracheae as a lesser character. Thus in his key to the subfamilies he stated that in the *Leeuwenhoekinae* the leg segmentation formula of the larva is 6, 6, 6 (i.e. that legs I, II and III have 6, 6, 6 segments respectively). In the *Apoloniinae*, as in the *Trombiculinae*, the leg segmentation formula is 7, 7, 7. By Wharton's key (1947a; largely repeated in Wharton and Fuller 1952, page 41) the larval *Neotrombidium*, with its segmentation formula of 7, 6, 6, would come down to the *Walchiinae*, but its affinities clearly lie elsewhere. Thus it does not fulfil the other two characters given for the *Walchiinae* (Wharton and Fuller 1952, page 91): that of expanded sensillae in the larva, and the presence of a papilla or a group of papillae on the dorsal surface of tarsus I in the nymph and adult.

Lawrence (1949, page 467), in describing the South African parasitic *Trombiculid* fauna, accepted Wharton's classification, with minor modification. He commented that the genus *Sauracella* Lawrence 1949, with its expanded sensillae and leg segmentation formula 7, 7, 7, could equally well be placed within the *Trombiculinae* or *Leeuwenhoekinae*. In discussing the systematics of these two subfamilies he commented that "Even the presence or absence of stigmata and tracheal trunks between the first coxa and the gnathosoma, which should from all considerations be a character of deep-seated significance, no longer retains its former importance, since none of the three new *Leeuwenhoekine* genera described [*Hyracarus*, *Austrombicula* and *Austracarus*] in this paper from mammals, have these tracheae. According to Wharton and Fuller (1952, page 96), *Comatacarus* Fwing 1942, placed in the *Leeuwenhoekinae*, also lacks these."

On the whole therefore, it would appear that the best decision is to allot the *Leeuwenhoekinae* no more than subfamily status, a view to which most students of these mites at present subscribe (for the sake of consistency, however, their family name has been retained in the title of the present paper).

The Synonymy of Neotrombidium

Womersley (1954) gave an account of six larval genera belonging to the *Trombidioidea*, among which were *Neotrombidium* Leonardi 1901 and *Cockingsia* Womersley 1954. The following comment was made on these mites: "This is a heterogeneous assemblage of genera, but on larval characters they would be included in an expanded subfamily *Apoloniinae*, a concept which the writer believes to be useful at the present state of knowledge. A clear line cannot at present be drawn between the *Leeuwenhoekidae*, a family largely

* This term was possibly used somewhat loosely by Womersley.

founded on larval characters, and the Trombidiidae, largely founded on adult characters . . . " and that "placing them in the Apoloniinae *sensu lato* must be regarded as no more than tentative". He retained the family Leenwenhoeekiidae, and in it he placed the Apoloniinae, but no modified definition of the latter was proposed.

Cockingsia tenuipes Womersley 1954 was described in that paper as a new genus and species from Malaya. If, however, it is compared with the description and figures given by the present writer (1954) for the larva of *Neotrombidium baringunense*, from reared specimens, as well as those given by Borland (1956) for larvae similarly reared of *N. tricuspidum*, it will be observed that *Cockingsia* is practically identical with larval *Neotrombidium*. Womersley (*loc. cit.*, pages 108, 109) stated erroneously (presumably deriving his data from Wharton, as he refers to personal correspondence with the latter writer) that the legs of the larval *Neotrombidium* are all 7-segmented. Actually, as stated above, in the larval *Neotrombidium* the leg segmentation formula is 7, 6, 6, as both the present writer (1954) and Borland (1956) have described, and as Womersley himself described in *Cockingsia*. The only significant point of difference between the description by Womersley of *Cockingsia* and the descriptions by myself and Borland of larval *Neotrombidium* is Womersley's statement that in *Cockingsia tenuipes* that "Spiracle between gnathosoma and coxae I present, but only beginning of tracheae observed". The present writer has re-examined his own specimens of the reared larvae of *N. baringunense* (bred as described earlier) and has been unable, as he has been previously, to find any stigmata or tracheae between the gnathosoma and coxa I of each side, and is convinced that such are not present. Nor does Borland refer to any, or figure any sign of them in his obviously carefully drawn figure of the larva of *N. tricuspidum*.

In an attempt to clarify this problem the writer has examined the type series (16 specimens) of *Cockingsia tenuipes* in the collection of the South Australian Museum. He has been unable to see any stigma or trachea in the position figured by Womersley. Occasionally in that situation the skin has tended to fold, and this could account for Womersley's description and figure. It may be commented that in the genus *Acomatocarus*, which is widespread in Australia and elsewhere, that the spiracle can be recognized without difficulty even in old mounts.

In the writer's opinion, therefore, *Cockingsia* Wom. 1954 is a synonym of *Neotrombidium* Leonardi 1901, and Womersley's species is allotted the name *Neotrombidium tenuipes* comb. nov. In that species, in the lateral parts of coxa I and III, there is a reticular pattern described by the writer (1954) and Borland (1956), reminiscent of the reticular pattern of the coxae of the postlarval stages, in their lateral parts. *N. tenuipes* is, however, quite a distinct species, and may be separated on biometric data quite easily from the other species, as recorded below.

With regard to *Monunguis* Wharton 1938, Borland (*loc. cit.*), following advice from Wharton, suggests that *Monunguis* may eventually have to be revived as a separate genus. Various morphological characters are given as evidence in support of that viewpoint, one such being that the larval *Monunguis streblida* Wharton 1938 has upon its dorsal scutum an "incipient crista", of which only faint traces can be made out in *Neotrombidium tricuspidum* Borland 1956. However, Borland himself destroys the force of that argument with the admission that "therefore, with respect to the scutum, *M. streblida* differs from *Neotrombidium* [*tricuspidum*] larvae in degree only". Borland continues by stating that other characters by which these two species differ are the greater number of dorsal setae and the greater plumosity of the dorsal setae in *Monunguis*, and the fact that the body (idiosoma) is pear-shaped while the other larvae assigned to *Neotrombidium* are of ovoid body form. With regard to the last character the

present writer is not prepared to concede at the present time that it is even of specific value, even in unmounted unengorged specimens. The other characters quoted to do not appear to the present writer to be of much significance generically, as they are largely differences of degree, and as acarologists customarily use these setal characters for the separation at the species level.

There are three discrepancies between Wharton's (1938) account of *Monunguis* and the characters of larval *Neotrombidium* as described by both the present writer and Borland. The first of these lies in the fact that Wharton claimed in his original account that coxa I and coxa II are separated on each side (and on that account suggested that *Monunguis* and *Rohaultia* Ouds, 1911 occupied an intermediate position between the families Trombidiidae and Erythracidae). Although the present writer made this point in his article in 1954, Borland (*loc. cit.*), although he quotes that article, has not seen fit to deal with it in his recent examination of a cotype of *M. streblida*. The second discrepancy is also of importance. Wharton (1938) stated that *Monunguis* resembled *Rohaultia* in another character, that of having "divided femora". Presumably this means that the legs are all 7-segmented, as Womersley stated (*see above*). The third discrepancy lies in Wharton's statement that in *Monunguis* there is a single seta in each coxa. In larval *Neotrombidium* there are two setae to coxa I, and one to each coxa II and III (Southcott 1954, Borland 1956). These second and third discrepancies likewise are not dealt with by Borland. It is quite clear that Wharton's *M. streblida* badly needs a critical re-examination, and description. Until such time as that is done, however, the present writer can see no reason against accepting the view proposed earlier by the writer (1954) and Borland (1956) that *Neotrombidium* and *Monunguis* are synonymous.

The following synonymy is therefore proposed:

***Neotrombidium* Leonardi 1901**

Trombidium Berlese, 1888 (*part*).

Neotrombidium Leonardi 1901, Berlese 1912, Hirst 1928, 1929, Womersley 1934, 1936, 1937, 1945, 1954 (post-larval forms), Thor 1935, 1936, Thor and Willmann (1947), Wharton 1947b, Baker and Wharton 1952, Andy 1954, Southcott 1954, Borland 1956.

Monunguis Wharton 1938 (larval).

Cockingsia Womersley 1954, Andy 1954 (larval).

***Neotrombidium* tridentifer n. sp.**

Fig. 1 A-H

Description of Adult (mostly from mounted specimen, Type, ACB 194) (Fig. 1 A-H): Colour vermilion in life. The body of the usual elongate shape for the genus, with its constricted middle ("figure of eight") (the type specimen is probably slightly swollen by the mounting). Body 1350 μ long by 570 μ wide; densely clothed with coarse 3-pronged setae as figured (Fig. 1 F-H), which are mostly directed posteriorly, the setae near the "shoulders" being an exception. Dorsal setae 40-50 μ long by 20-24 μ wide across the prongs. The lateral prongs are coarsely barbed and pointed. The central element of the seta is expanded distally, and is club-like, with projecting or sessile bract-like or bead-like cilia-tions; below the central prong has a double row of fringing, sharp-pointed cilia-tions. The dorsal setae become coarser posteriorad. On the ventral surface of the idiosoma the investing setae are similar to the dorsal, but are slightly smaller and more delicately fashioned.

Eyes cannot be seen in any of the type series. It cannot be decided definitely whether they are present or absent from these specimens, owing to the density of the dorsal setation (in *N. barringtonense* each lateral pair of lenses is but lightly chitinised).

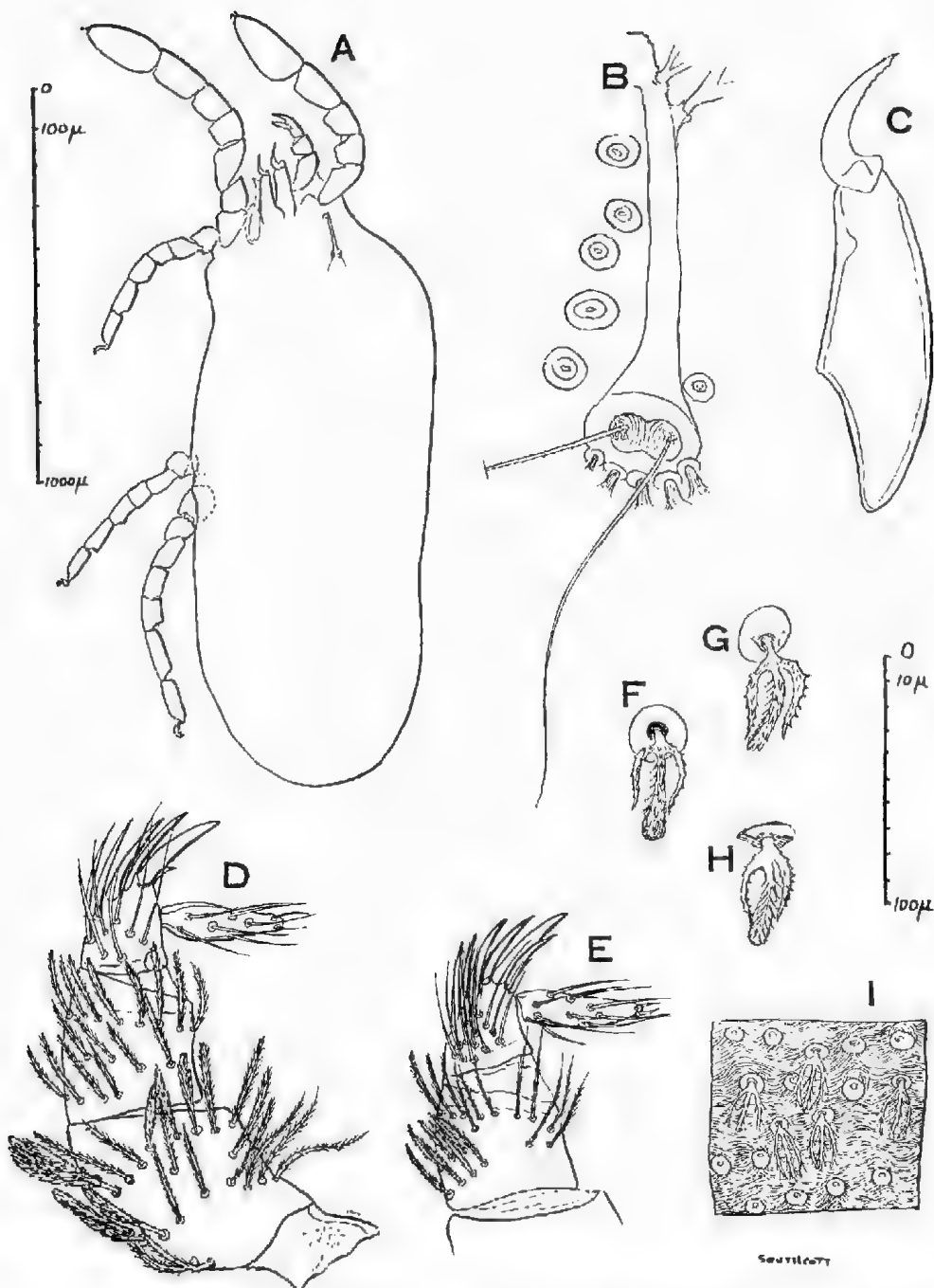


Fig. 1 A-II.—*Neotrombidium tridentifer* n. sp. Adult. A: entire, setae omitted, to scale on left; B: crista; C: right chela; D: left palp, external view; E: left palp, internal view; F, G, H: dorsal setae, F, G, dorsal views, H ventral view; I *Neotrombidium barringtonense* Hirst 1928, adult: piece of skin of the dorsum with setae, to same scale as F, G, H (B-I all to same scale, that on right of figure).

Dorsal crista as figured, about 165μ long, provided with a single sensillary area, large, at its posterior end; an area 43μ across by 34μ long, with two filiform very finely barbed sensillary setae 150μ long. In the type specimen the anterior end of the crista and tectal area are obscured by distortion and the heavy investiture, but in specimen ACB 263A (paratype) the pair of tectal setae are visible, strong, pointed, strongly ciliated, 64μ long.

Legs as figured, I 800μ long, II 515μ , III 525μ , IV 725μ (all lengths including coxae and claws). The legs are clothed with a normal type of Trombidiid setation, there being no trifurcate setae present. Proximally on the legs the setae are lanceolate or lanceolate-clavate, with coarse, pointed ciliations; distally the setae are fine, pointed, with hair-like ciliations. The lateral (distal) half of the coxa of each leg is patterned with punctae in each leg, similar to that of *N. barringtonense*, but with the spaces smaller owing to the coarser reticulation septa. Tarsus I is 200μ long by 90μ high (exclusive of claws); metatarsus I 128μ long by 76μ high; tarsus IV 130μ long by 40μ high (exclusive of claws); metatarsus IV 122μ long by 50μ high.

Palpi as figured. The palpal tibia carries a strong claw with a basal coarse barb or peg, and one accessory tooth ventromedially; dorsally there is also a row of 4 stout accessory spines to the claw, as figured. The palpal tarsus is slender, with fine spiniform setae.

Chelicerae as figured, with a fairly strong falciform, pointed movable chela with a distal dorsal row of 6 minute denticles.

Genitalia of adult are as previously recorded for this genus, with the normal labia majora, each provided with two long suckers and with a row of ciliated tapering setae. The genital aperture is surrounded by rows of inwardly pointing, elongated and ciliated 3-pronged setae.

Localities: Specimens ACB 194A (type) and ACB 194B (paratype) were found among leaf litter at the base of *Eucalyptus* sp., Palm Beach, Cairns, Queensland, on 12th December, 1943. Specimen ACB 263A (paratype) was obtained under bark of *Eucalyptus* sp., along with 4 specimens of *N. barringtonense* Hirst 1928 (ACB 263B-E), at Dead Man's Gully, Cairns, Queensland, at Map Reference (Cairns 1:63,360) 614863, 29th November 1943. (All specimens collected by writer; in writer's collection.)

The Systematic Position of Neotrombidium tridentifer

This species (known only from the adult) can be distinguished quite easily from the only other adult *Neotrombidium* described from Australia, *N. barringtonense* Hirst 1928, on the structure of the dorsal setae. In *N. tridentifer* the dorsal setae are of a coarse structure, to 50μ long, with unequal prongs. In *N. barringtonense* the dorsal setae are smaller, to 30μ long, and consist of three delicate and nearly equal, flexible, finely ciliated prongs. These differences are illustrated in Fig. 1 G-I.

Neotrombidium barringtonense Hirst 1928

Fig. 1 I

Six specimens of this species were collected by the writer in the Trinity Bay area of north Queensland. The dorsal setae on a piece of the integument of one of these (ACB 200) are shown in Fig. 1 I. The following is a list of the specimens and localities: (1) One specimen, ACB 200, under bark of *Eucalyptus* sp., Dead Man's Gully, Map Reference (Cairns 1:63,360) 617863, 31st December 1943; (2) Four specimens, ACB 263B-E, along with specimen ACB 263A, a paratype of *N. tridentifer* n. sp., under bark of *Eucalyptus* sp., Dead Man's Gully, Map Reference 614863, 29th November 1943; (3) one specimen, ACB 581, same locality, Map Reference 614863, 2nd January 1944. (All specimens in writer's collection.)

The Species of *Neotrombidium*

The species of the genus known at the present time are now:

Adults:

- N. fuscigerum* Leonardi 1901, genotype, Argentine.
- N. ophthalmicum* (sic) (Berlese 1888), Paraguay.
- N. tricuspidum* Borland 1956, N. Carolina, U.S.A.
- N. barringtonense* Hirst 1928, Australia.
- N. tridentifer* n. sp., north Queensland, Australia.

Larvae:

- N. tricuspidum* Borland 1956, as above (reared and collected free).
- N. streblidum* (Wharton 1938) (= *Monunguis* Wharton 1938), Mexico.
- N. sp.* undescribed, Borland 1956, N. America.
- N. barringtonense* Hirst 1928, as above (reared).
- N. tenuipes* (Womersley 1954) (= *Cockingsia* Womersley 1954), Malaya.

The Systematics of the Larval Species

Of the larval species described, there is no difficulty in separating the Mexican species, *N. streblidum*, on the characters of the setae. Below are given, in tabular form, the Standard Data of *N. barringtonense* for the specimen described by the writer in 1954, and compared with the other species for which these data are available, *N. tenuipes* and *N. tricuspidum*.

Standard Data (in micra) for Larval *Neotrombidium*.

	<i>N. tenuipes</i> after Womersley 1954, from 13 specimens; means)	<i>N. tricuspidum</i> after Borland 1956		<i>N. barrin- gunense</i>
		Holotype	Mean of 9 spec.	
AW	44.6	55	52	51
PW	71.6	74	77	64
SB	42.4	52	51	43
ASB	67.2	81	81	69
PSB	14.0	18	18	23
SD	81.2	99	99	92
A-P	36.2	40	39	24
AM	29.8	28	28	22
AL	33.0	21	21	22
PL	22.6	18	20	18
Sens.	75.6	74	69	46
AMB*	—	21	19	18
DS	32 to 42	30	—	to 26

* The distance between the two AM setae.

As can be seen from the above, these three species differ significantly in a number of biometric data. Thus *N. tenuipes* has longer dorsal setae and AL setae than the other two species; *N. tricuspidum* has larger dimensions for SB, ASB, SD; *N. barringtonense* has smaller PW, A-P, AM and Sens.

A Note on the Biology of the Genus

Neotrombidium streblidum (Wharton 1938), known only from the larva, was captured parasitic on the Streblid flies *Pterellipsis araneae* Coquillett and *Trichobius dugesi* Townsend parasitic on the bat *Artibeus jamaicensis yucatanicus* (Allen) from a cave in Yucatan, Mexico. Womersley (1954) recorded *N. tenuipes* (Wom. 1954) "from specimens taken from the wings of a giant longicorn beetle from Sungai Buloh, Selangor, Malaya, 17.viii.1948 (J. R. Audy)". Borland (1956) recorded *Neotrombidium* sp. (an undescribed new species) "collected by Werner and Nutting on *Cymatodera peninsularis* (Coleoptera: Cleridae) in Brown's Canyon [,] Baboquivieri Mts., Arizona, July 18, 1949", and also that larvae of *N. tricuspidum* Borland 1956 were collected "parasitic on *Monochamus carolinensis* Oliv. (Coleoptera: Cerambycidae)". Borland recorded also some inconclusive experiments to get reared larvae of *N. tricuspidum* to feed on some other species of beetles of the families Staphylinidae and Carabidae. On one occasion some of the larvae disappeared under the elytra of one species of Carabid, and were not recovered.

Thus, apart from the case of *N. streblidum*, the available evidence suggests that Coleoptera act as the hosts of the larvae, and possibly that the family Cerambycidae play an important role. Although the utilization of such hosts would account for a number of puzzling features in the biology of these mites, it is apparent that further investigation is required for firm conclusions to be drawn.

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ON VATACARUS IPOIDES N. GEN., N. SP. (ACARINA: TROMBIDIOIDEA) A NEW RESPIRATORY ENDOPARASITE FROM A PACIFIC SEA-SNAKE

BY R. V. SOUTHCOTT

Summary

A hitherto undescribed acarine is described, from New Caledonia, remarkable for being endoparasitic within the respiratory passages of a sea-snake (*Laticauda laticaudata* (L.)), with maggot-like modification of the body shape. It is named *Vatacarus ipoides* n. gen., n. sp. Only the larva is known. Within the superfamily Trombidioidea, where this mite is placed, it shows the most complete adaptation to endoparasitism that has so far been observed.

Some account of the biology of the mite is given. from the observations of its discoverer, Mr. J. Rageau.

The affinities of the mite are discussed, and a new family Vatacaridae (or subfamily Vatacarinae) is erected within the Trombidioidea, and defined. The classification of the superfamilies of the Prostigmata is discussed. The superfamily Trombidioidea Banks, 1894, is redefined. A superfamily *Anystoidea* nov. is defined tentatively, and discussed briefly.

The term "ipomorphy" is proposed for a worm-like or maggot-like adaptation of form, of animals not normally so. Within the Acarina such modification of body shape appears in general to be a response to endoparasitism, and is seen in various suborders. Endoparasitism within the Acarina is discussed.

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INTRODUCTION

Recently, Mr. J. Rageau, entomologist to the Institut Français d'Océanie, Nouméa, New Caledonia, has sent the writer some specimens of a maggot-like endoparasite of the respiratory passages of a sea-snake, from New Caledonia, recognizing that they were acarine in nature. Examination of these specimens by the writer has shown that they are larval Trombidioid mites of bizarre appearance. Although endoparasitism has been described in certain instances in some of the Trombidoidea (see further below), such complete adaptation of the parasite to the host, both in the site used (the tracheal passages), and in the form affected by the parasite, has not hitherto been recorded for any Trombidioid mite. Only the larva of this form is known, and its life-history is largely unknown. It is proposed to describe it here as *Vatacarus ipoides* n. gen., n. sp., and to discuss its affinities. Comment will also be made on endoparasitism within the Acarina.

The writer is greatly indebted to Mr. Rageau for the opportunity of studying this mite, and for permission to incorporate his observations.

DESCRIPTIVE ACCOUNT

(a) *Vatacarus* n. gen.

Definition (larva only): A Trombidioid mite with the body capable of increasing considerably in size, to several millimetres long; shape maggot-like, with conical or mamillary projections, these more prominent posteriorly, and arising underneath the normal idiosomal setae. Coxae I and II separated. Urstigma present. Gnathosoma not greatly modified. Cheliceral fangs recurved dorsally, hinged, weakly bicuspid. Palpal tibial claw with two hooks, bent ventrally, and placed vertically to each other (i.e. sagittally). Eyes apparently absent. Dorsal scutum trapezoidal, widest anteriorly, with a single anteromedian

seta, two anterolateral setae, and a pair of filiform sensillary setae arising laterally, between the levels of the anterior and posterior non-sensillary scutal setae.

Genotype *Vatacarus ipoides* n. gen., n. sp.

(b) *Vatacarus ipoides* n. gen., n. sp.

Figs. 1-4*

Description of Larva (Figs. 1-4): Colour in life a bright reddish-orange, in alcohol-preserved specimens a dirty cream. Length of type specimen (ACC 335A), one of the larger specimens, 4.5 mm., width 1.5 mm. (smaller specimens were 2 mm. long or more, and other idiosomal dimensions in proportion). The animal is maggot-like in shape, the idiosoma swollen, and with the hysterosoma greatly prolonged, the latter accounting for three-quarters of the length of the animal. In addition, the idiosoma is studded with a number of mamillae or conical projections, these being more prominent dorsally and posteriorly, giving the body the appearance of a mace or studded club. The anterior part of the body is produced to a large boss, but is free from the idiosomal projections. Each idiosomal projection is developed under a normal idiosomal seta, which is short, spiniform or nearly so with adpressed ciliations, and with a slight bulge at the base of the seta. The dorsal setae are $34-62\mu$ long, and are regularly arranged in rows across the dorsum as figured, these rows becoming less regular posteriorly (see Fig. 1 A-D). The dorsal seta arises from the summit of the projection, or a little way down its anterior face. The ventral projections are smaller, rather more mamillate, and arranged somewhat irregularly, as figured, nevertheless each carries a normal idiosomal seta. The cuticle is finely striate under the higher magnifications of the microscope; probably distension has made the striae less obvious.

The dorsal scutum is carried at the anterior pole of the animal, in a slightly recessed area. It is finely punctate all over, quadrangular (trapezoidal) with rounded corners, widest anteriorly, with projecting anterolateral angles, a sinuous anterior margin, concave lateral margins and a slightly convex posterior margin. It carries a pair of filiform sensillary setae, 87μ long, arising in sensillae placed close to the lateral borders of the shield, and with an aperture partly occluded by an eye-like transverse slit, 14μ across by 6μ high, at about the level of the middle of the shield. The scutal non-sensillary setae are stiff, somewhat constricted at their bases, then expanding and becoming elongate-lanceolate, and finally filiform; almost simple except for some adpressed ciliations as figured. With one AM, two ALs and two PLs, and thus of Trombiculid facies. There are some chitinisations in the skin near the shield (see Fig. 2B). Using the customary terminology for the Trombiculid mites the standard data of the dorsal scutum of a paratype specimen (ACC 335B) are, in micra:

AW	PW	SB	ASB	PSB	SD	A-P	AM	AL	PL	Sens	PW/SD
92	83	58	35	41	76	40	58	55	62	90	1.09

Eyes are not visible, and apparently are absent, although this point may not be finally decided until unengorged specimens are available.

The legs are of normal size among the Trombidioidea, but appear small when compared with the bulk of the larva; lengths I 370μ , II 350μ , III 370μ (including coxae and claws). All legs of 7 segments, including the coxa, and with chaetotaxy as figured. Each coxa is set in a space set between the rounded bulgings in the idiosoma; this is most marked in leg III, where the leg arises from a large boss. Each coxa carries a single seta, placed as figured, and similar to the scutal non-sensillary setae. The majority of the normal leg setae

* Figs. 1 A-E, 2 C are from ACC 335A (Type); Figs. 2 A, B, D, E, 3 A, B, 4 A, B from paratype ACC 335B; 3 C, D from paratype ACC 335C.

are simple or almost so, except terminally on the leg, where the ciliations are prominent. Tarsus I and II and metatarsus I and II each carry a single solenoidal (striate) seta. Short spiniform setae and famuli (= "microsensory setae") are present as figured. Tarsi of legs with two simple claws and an empodium; the latter tending to be retroflexed. Tarsus I 104μ long (to base

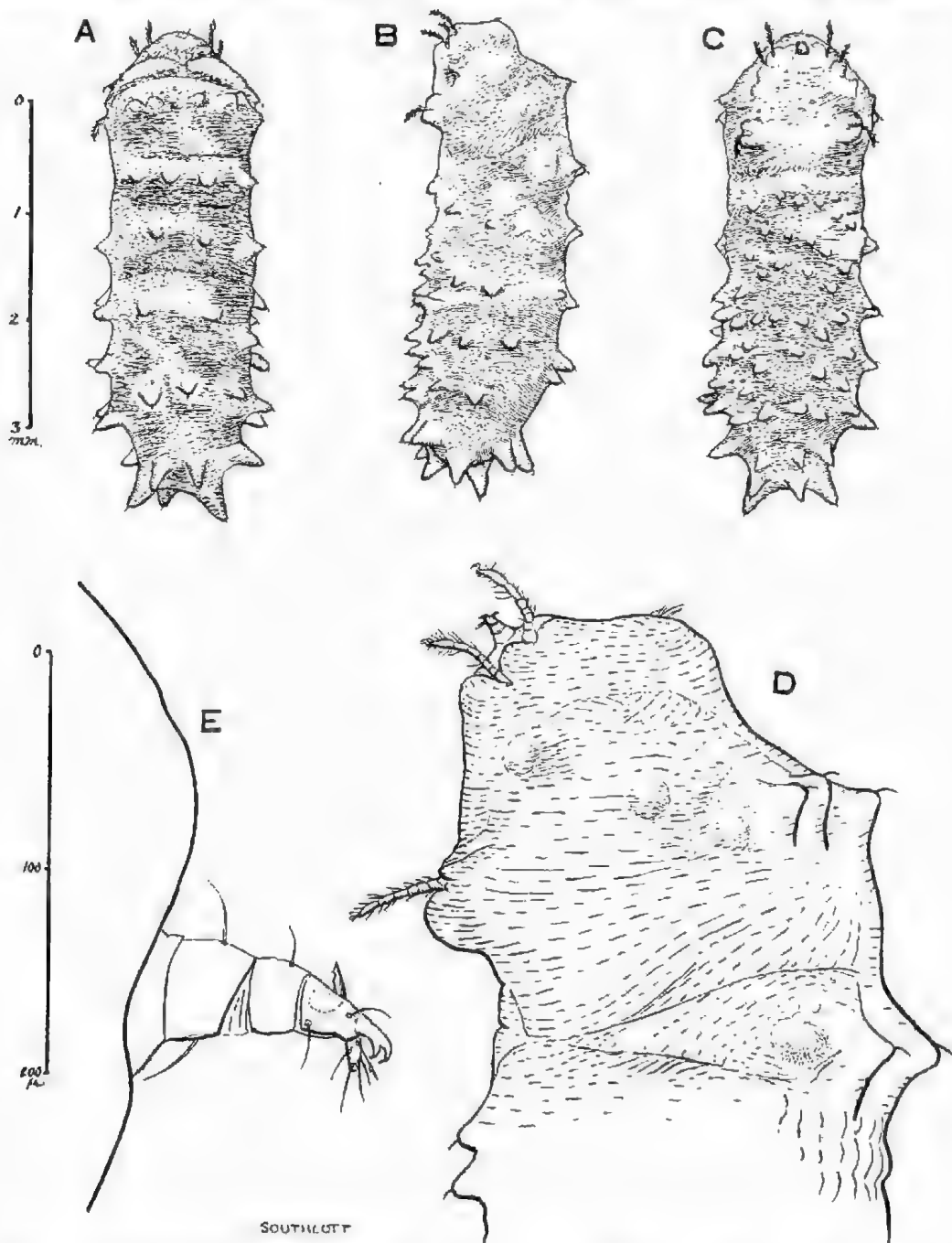


Fig. 1.—*Vatacarus ipoides* n. gen., n. sp., larva. A, B, C entire, to scale on left. A, dorsal aspect; B, lateral aspect; C, ventral aspect; D, anterior part of larva, further enlarged; E, lateral aspect of gnathosoma and adjacent part of idiosoma, to scale on left.

of claws) by 25μ high; II 83μ long, measured similarly, by 25μ high; III similarly 83μ long by 24μ high. Metatarsus (tibia) I 66μ long, II 56μ , III 58μ .

An urstigma is present in front of coxa II, and in front of this is a projecting spur (see Fig. 4). Coxa I and II are well separated. Radiating around

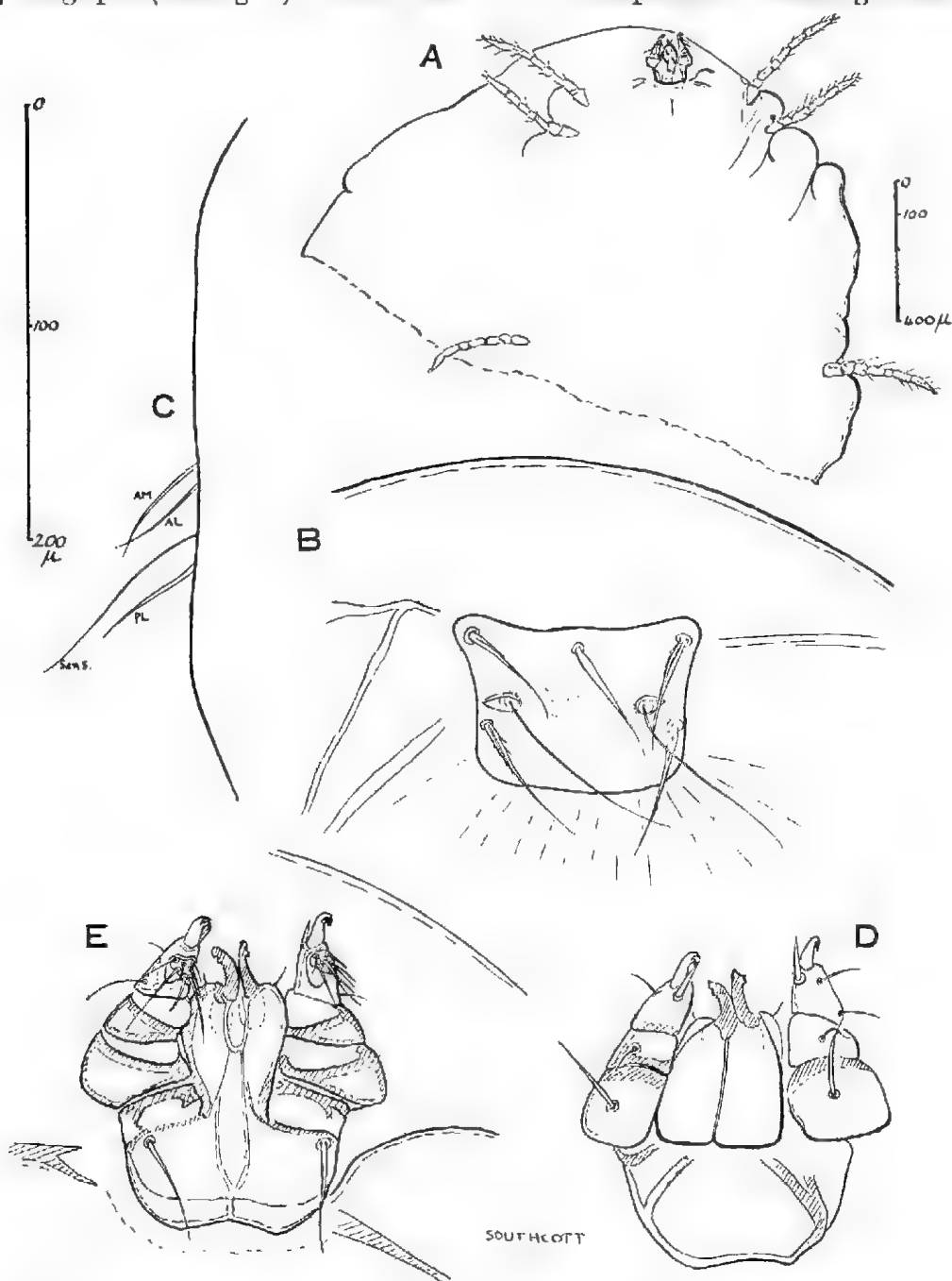


Fig. 2.—*Vatacarus ipoides* n. gen., n. sp., larva. A, anterior part of ventral surface, somewhat distorted in mounting, from compression, to scale on right; B, dorsal scutum and adjacent part of idiosoma, flattened specimen; C, lateral aspect of anterior pole of body, undistorted, with dorsal scutum hidden in its small recess, but with the scutal setae showing; D, gnathosoma from above; E, gnathosoma from below (B, C, D, E all to scale on left).

the coxae are fine lines beneath the cuticle in specimens mounted in lactic acid or in polyvinyl alcohol-lactophenol mountant, and between coxae I and II, and around the dorsal scutum; these do not appear to be muscular as elsewhere muscles are seen in these preparations which are easily recognized from the well-marked cross-striations. No evidence has been found of a true trachea and stigma (as e.g. occurs in *Acomatacarus*, family Trombiculidae).

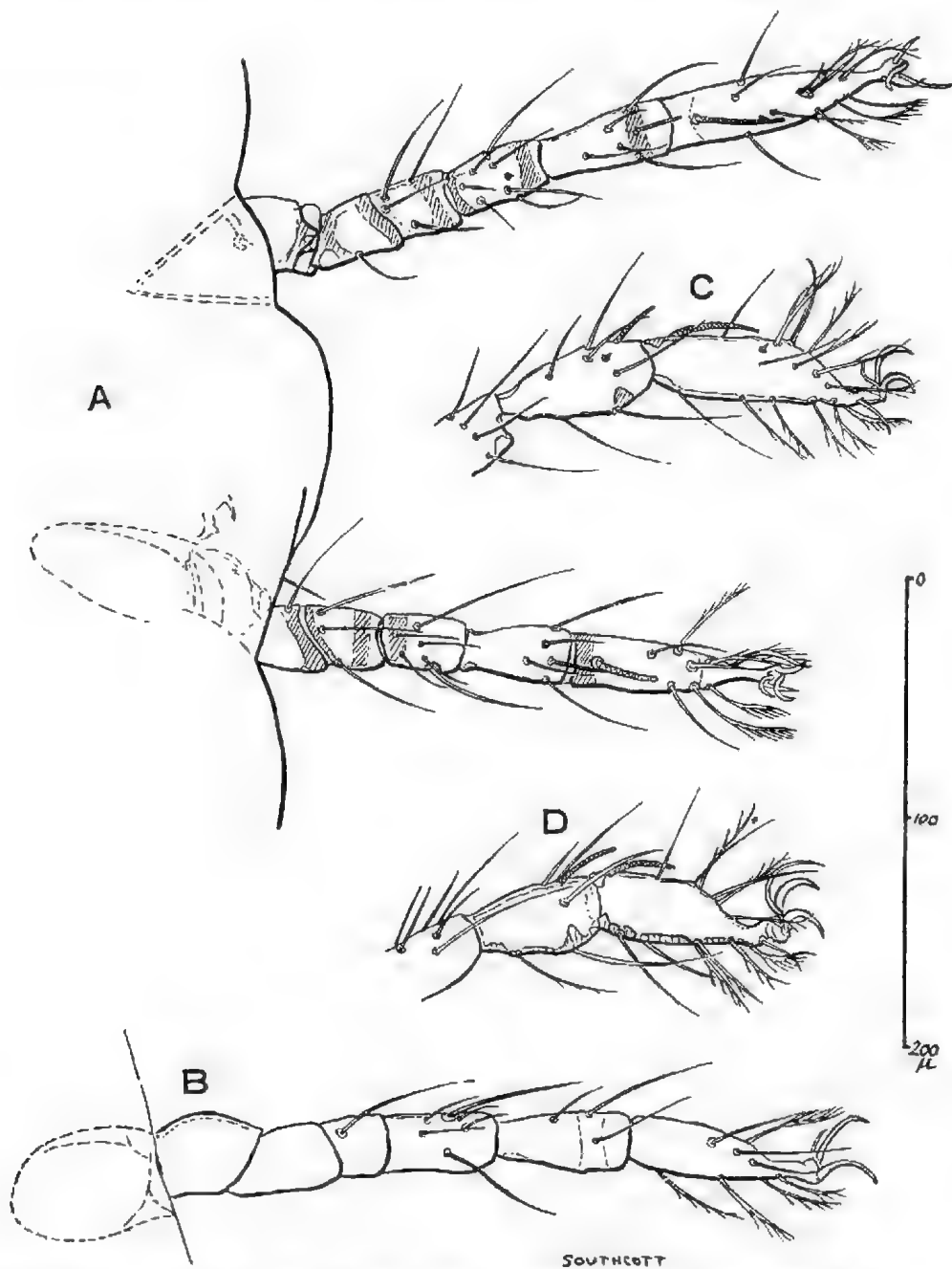


Fig. 3.—*Vutacarus ipoides* n. gen., n. sp., larva. A, dorsal aspect of legs I and II; B, dorsal aspect of leg III (same specimen); C, D, lateral aspects of legs I and II respectively of another specimen. All to scale shown.

The gnathosoma is fairly heavily chitinized, and is carried underneath the projecting anterior pole of the larva, lying level with the first pair of coxae. The palpi and chelicerae bases stout and rather compact. The cheliceral digit hinged, recurved dorsally, the blade without ventral teeth, but dorsally with a weak cusp set a little behind the terminal cusp. Galeal seta nude, 12μ long. Palpal setae nude. Seta on palpal femur and on basis capituli ("palpal coxal seta") stiff, elongate-lanceolate, similar to scutal non-sensillary setae; other palpal setae more slender, except the dorsal palpal tibial seta which is a stout simple pointed peg. Palpal femur, genu, tibia, tarsus with 1, 1, 3, 8 setae respectively. The palpal tibial claw with two ventrally curved sharp hooks, set sagittally to each other (see Fig. 1 E).

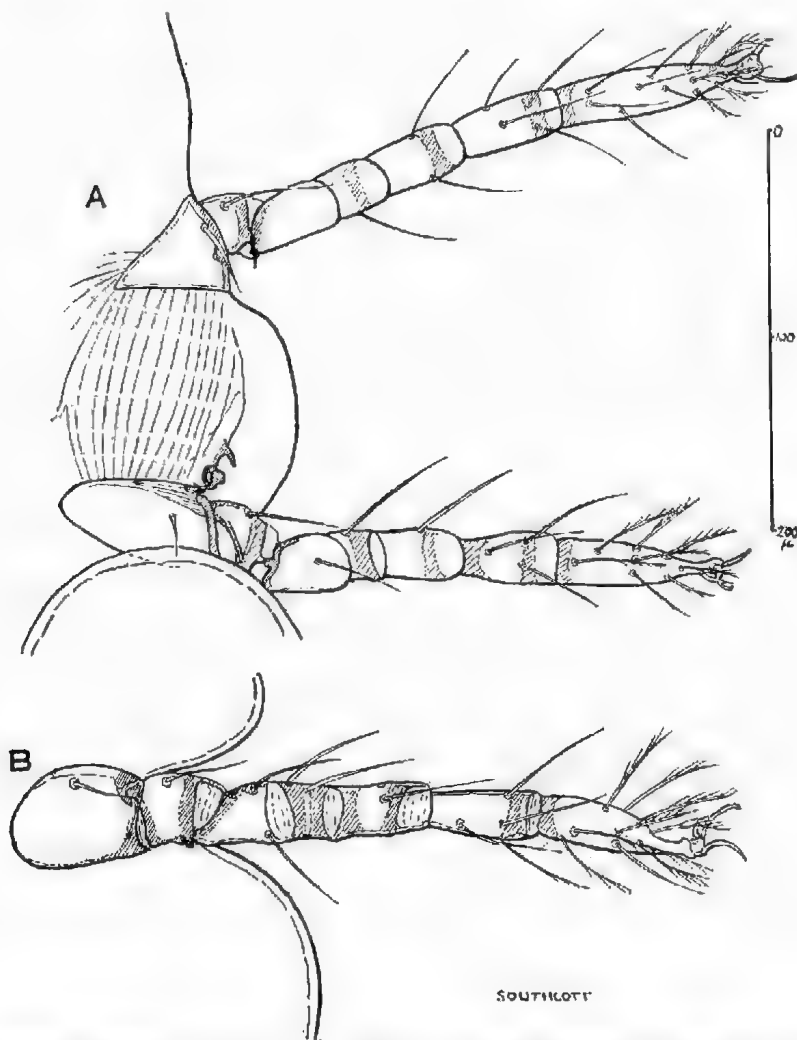


Fig. 4.—*Vatacarus ipoides* n. gen., n. sp., larva. A, ventral aspect of legs I and II, mounted specimen, same as in Fig. 3A; B, ventral aspect of leg III, same specimen. All to scale shown.

Locality: In respiratory passages ("trachea and lungs"; see below) of a sea-snake, *Laticauda* (= *Platurus*) *laticaudata* (L.), at Anse Vata, Nouméa, New Caledonia, 22nd September, 1955, collected by Mr. J. Rageau; 15 specimens forwarded, number ACC 335. All specimens in writer's collection.

Biology of *Vatacarus ipoiles*

The following account of various aspects of the biology of this larval mite has been received from Mr. Rageau:

Voici les réponses à vos questions sur la biologie de ces acariens:

(1) Localisation chez l'hôte: trachée-artère et poumon, remontant jusqu'aux narines et au pharynx après la mort du serpent.

(2) Mouvements: très limités. Les acariens se déplaçaient lentement par des mouvements de reptation sans utiliser leurs pattes. Leur corps était contractile.

(3) Effet pathologique sur l'hôte: apparemment aucun effet. Le serpent capturé sur la plage était très vigoureux et ne semblait avoir de difficultés respiratoires. En disséquant l'appareil respiratoire, je n'ai pas observé des lésions. Il n'y avait pas de sang à l'intérieur du tube digestif des acariens. Aussi est-il probable qu'ils se nourrissent de mucus et de cellules épithéliales (see the comment below—R.V.S.).

(4) Biologie de l'hôte: *Laticauda laticaudata* (L.), Hydrophiidae Laticaudinae, est une espèce marine très fréquente au voisinage des côtes de la Nouvelle-Calédonie et qui vient souvent à terre, en particulier la nuit. Ainsi elle est abondante dans les îlots au voisinage de la Grande Terre et a même l'habitude de se réfugier dans les tentes des campeurs. Elle est attirée par la chaleur et lorsque l'on dort sur la plage, il arrive que l'on retrouve un de ces serpents enroulé autour de soi ou dans les vêtements au matin. Leurs écailles ventrales développées permettent aux *Laticauda* de se déplacer facilement sur le sol et de parcourir des distances importantes. Ces serpents sont très apathiques et ont la réputation d'être inoffensifs: les pêcheurs et même les enfants les prennent à la main, sans précautions. Ils vivent uniquement de poissons. Ils pénètrent dans les estuaires mais ne semblent pas remonter dans les eaux douces. On peut donc supposer que leurs parasites sont apparentés à des formes terrestres plutôt qu'à des formes d'eau douce. Une espèce voisine, *Laticauda colubrina* Schneider, est également très commune sur les côtes calédoniennes et a une biologie similaire.

"Vous trouverez des dessins de ce serpent et des détails sur sa biologie dans: R. Bourret (1934) Les serpents marins de l'Indochine française, Institut océanographique de l'Indochine, 25e note, pp. 12-18 et planche II, Hanoi.

"Enfin, les acariens ont une coloration orange vif, tirant sur le rouge, lorsqu'ils sont vivants; cette pigmentation disparaît en alcool. J'en ai recueilli une cinquantaine d'exemplaires sur l'unique *Laticauda* dissecqué mais il est probable que le serpent en avait déjà rejeté un certain nombre au cours de son agonie car j'ai trouvé les premiers exemplaires dans l'eau du bassin où venait de mourir le serpent".

From the observations of Mr. Rageau, and the extreme adaptation of form of the larva, there need be no doubt that this mite spends the greater part of its larval stage in the respiratory passages of the snake. From the structure of its mouthparts and its affinities, to be discussed below, the present writer concludes that it feeds upon tissue fluid obtained from the host, in the usual manner of the Trombidioidea. There need not necessarily be a tissue reaction to such feeding in a vertebrate, as e.g. in many cases in Trombiculid mite biting in birds and mammals, as well as in reptiles, there is no apparent reaction to ordinary observation (without histological study, i.e.).

At the present time the remainder of the life-history of this mite is conjectural. Presumably the post-larval stages of the mite are free-living, and are to be sought in the soil at situations where the snakes come ashore.

Comment on the Superfamily Trombidioidea

In attempting to place *Vulacarus* systematically it is necessary to re-examine and re-define the superfamily Trombidioidea. Such a procedure will also be useful in other directions, for systematic purposes. As far as the writer has been able to determine, the superfamily term Trombidioidea was introduced as such by Banks (1894). In his classification of the Acarina (1904, 1915) Banks used the terms Mesostigmata Canestrini 1891, Prostigmata Kramer 1877 and Cryptostigmata Canestrini 1896 as suborders, as he stated. In the Prostigmata he included the superfamilies Eupodoidea, Trombidioidea (sic) and Hydrachnoidea. The last of these constitutes an ecological rather than a morphological group. In the opinion of the present writer it is unfortunate that these relatively simple suggestions of Banks were almost completely ignored by European workers, who preferred to set up a complicated system of groupings given the names of cohorts, subcohorts and phalanges within the Prostigmata. The possibility offered by Banks' schema of providing a useful basis for superfamily classification was overlooked or ignored.

Banks (1915) included in the superfamily Trombidioidea the families Caceuliidae, Trombidiidae, Anystidae (= Erythraeidae Banks 1894), Erythraeidae (= Rhyncholophidae Banks 1894), and Tetranychidae. The determining morphological criteria for the Trombidioidea (as against its nearest superfamily in the key, the Eupodoidea) was stated in the key (1915) as "Last joint [segment] of palp forms a thumb to the preceding, which ends in a claw (a few exceptions), body often with many hairs"—this referring principally to the adult forms.

In 1909 Reuter proposed the suborder Trombidiformes, the definition given (p. 246) (in a footnote only) being: "= Prostigmata + Heterostigmata Berlese (1889), vielleicht mit Einschluss der *Labidostomidae* (*Nicoletiellidae*)". The Trombidioidea (sic) was the only superfamily placed in that suborder, which was considered as consisting of the four families Trombidiidae, Tarsonemidae, Hydrachnidae and Halacaridae. The family Trombidiidae was used in a wide sense, even for that time, as it was stated elsewhere in that paper (p. 243) that it was "mit mehreren Unterfamilien, auch derjenigen der *Bdellinae*".

In 1909 Oudemans revised the classification of the Prostigmata Kramer 1877, introducing the system of cohorts, subcohorts and phalanges referred to above, all of these with suprafamilial status. The term Trombidioidea was not used. This scheme was used later by Oudemans (1923) and by Vitzthum (1931, 1940-1943), with certain modifications.

At the present time the status of the superfamilies among the Prostigmata at least needs clarification, as Baker and Wharton (1952) have pointed out in their excellent textbook of acarology. In fact, among the Trombidiformes these authors found it in general necessary to omit the superfamilies from the classification. Some clarification has been made by the introduction of the concept of the superfamily Tetranychosidea by Baker and Pritchard (1953). Grandjean (1944) introduced the superfamily term Raphignathosidea, virtually without definition. This appears to be a valid group, and the present writer has attempted to define this concept in another paper (1957a). Another useful suggestion was made by Grandjean (1947), that the "Supercohort" Apobolostigmata Oudemans 1909 be replaced by Erythraeosidea Grandjean 1947. The present writer has concurred with this suggestion elsewhere (1957b). Acting along the same lines it appears to the writer that the superfamily term Trombidioidea could usefully take the place of Oudemans' (1909) "Supercohort" Eogonostigmata. The following restricted definition is therefore proposed:

Trombidioidea* Banks 1894 (restricted)

Definition: Trombidiformes (Prostigmata) in which the larva has an urstigma.† Chelicera with a hinged blade, not styloform (exsertile). Post-larval stages with genital suckers.

From the "Cohort" Eleutherengona Oudemans 1909, Vitzthum 1931 the superfamilies Tetranychoidae, Raphignathoidae and Demodicoidea have been separated. Among the remaining families are four which form a fairly precise group, these being the Anystidae, Pterygosomidae, Pseudocheylidae and Teneriffidae. These mites are mainly predatory, but the Pterygosomidae are ectoparasitic on reptiles. For this group a superfamily Anystoidea nov. is proposed, with the following tentative definition:

Anystoidea n. superfam.

Definition: Peritreme prominent, transverse, placed anteriorly on idiosoma, and may be protruding. Chelicerae hinged (not exsertile). Coxae in one or two groups on each side. Parasitic or predatory. Larva lacking urstigma, similar to adult.

The systematics of the Trombidiformes will be considered further in later papers.

The Systematic Position of Vatacarus

On morphological grounds there is no doubt that *Vatacarus* should be placed in the Trombidioidea. A typical urstigma is present, and the chelicerae are hinged. The spur near the urstigma appears to belong to the latter, and is possibly of some morphological interest, but no importance can be given to it systematically. The mouthparts are typical of the Trombidioidea, and appear to resemble those of some of the water mites.

However, among the Trombidioidea the genus *Vatacarus* is unusual in having coxa I and II separated on each side. It does not appear reasonable to ascribe this separation to the distention of the larva, although this is extreme, as in other members of the Trombidioidea, considerable distension of the larva may occur without the coxae separating, these being in fact fused together. The separation of the coxae is in fact more suggestive of the Erythraeoidea. Hitherto the only mites placed in the Trombidioidea (as defined above) for which separated coxae I and II have been recorded are *Rohaultia* Oudemans 1911 and *Monunguis* Wharton 1938. The present writer has proposed reasons elsewhere for believing that the description by Wharton (1938) of this feature in *Monunguis* (= *Neotrombidium* Leonardi 1901) is erroneous (Southcott 1954a, 1957c). With regard to *Rohaultia*, Vitzthum (1931) stated that that genus was the larva of *Johnstoniana* George 1909, but as the writer (1954a, 1957c) has pointed out, experimental proof of that claim has not been furnished by any writer. To the present writer *Rohaultia* is rather suggestive of some of the water mites. Its habit of parasitizing Tipulid flies is of interest, and does not conflict with the last suggestion. However, a study of the morphology of *Rohaultia* does not shed much light on the systematic position of *Vatacarus*, as these genera do not appear to be closely related.

The systematist is in fact here placed in the dilemma of accepting the apparent affinities of *Vatacarus* with the Trombiculidae on the one hand, which would logically lead to the founding of a new subfamily Vatacarinae of the Trombiculidae, or of accepting the importance of the separation of the coxae,

* Frieder (1955) has proposed "Trombidioidea (sic) n. superfam.", this term being used in the sense of Trombiculidae Leach 1815 as used by most authors; apparently in ignorance of the fact that this term has been current for over 60 years.

† In one instance—that of *Microtrombidium hirsutum* Womersley 1945—the larval stage of the mite is omitted from the life history (Southcott, 1946), but it is obvious on other grounds that this mite is a member of the Microtrombidinae.

and of founding a new family, the Vatacaridae. The discovery of the adult forms of *Vatacarus* will not necessarily aid in the problem, as amongst comparable mites the classification at the present time is based largely on larval characters. Both in morphological and biological features *Vatacarus* is one of the most aberrant of the Trombidioidea, and the writer favours the latter course, and proposes:

Vatacaridae n. fam.

Definition: Trombidioid mites with maggot-like ("ipomorphic") larvae. Coxae I and II widely separated. Dorsal scutum present, with one pair of sensillae. Endoparasitic in the respiratory system of sea-snakes.*

The inclusion of a biological character in the family definition is in keeping with previous practice among comparable mites. Thus Ewing (1944) included such in founding the family Trombiculidae, and separating it from the Trombididae. Such a procedure among the Acarina was advocated by e.g. Banks (1915, p. 17) at the generic level of classification.

Respiratory Endoparasitism of Snakes by Acarina

Various mites have exploited the respiratory passages of snakes as a biological niche. Turk (1947), in a review of these, has listed mites of the families Liponyssidae, Isodorhynchidae, Eutonyssidae and Pneumophionyssidae. All of these, however, belong to the suborder Mesostigmata.

Vatacarus ipoides is so far the only Trombidioid mite which has been found to use this niche. Some comment on the genus *Hemitrombicula* Ewing 1938 will be made below.

Endoparasitism Among the Trombidioidea

Among the Trombidioidea there are many species parasitic on vertebrates, the majority of these belonging to the Trombiculidae. Among such parasitic mites various moves toward endoparasitism may be noted. At one end of the scale we may list e.g. *Babiania bulbifera* Southcott 1954, which appears to show the beginning of such a process of host adaptation by hiding completely under a scale of its lizard host, and by having a flattened body (we may note in passing some similarity between the dorsal scutum of *B. bulbifera* and *Vatacarus ipoides*). We may next refer to *Schöngastia* (*Schöngastia*) *oculicola* Womersley 1952, obtained from the conjunctival sac of *Leggada booduga fuvideiventris* (Blyth) (Mammalia) from Ceylon. Audy (1954, p. 159) commented on the habitat of this mite, which he placed in the genus *Doloieta* Oudemans 1910 (Audy, 1954), and referred to other Trombiculid mites which have assumed an intranasal site of parasitization. These have been recorded also by Fain and Verecannen-Grandjean (1953), Verecannen-Grandjean (1953), Audy and Verecannen-Grandjean (1955) and Fain (1955). The group is still under study, but apparently a number of species have utilized this niche.

Nevertheless, it is apparent that in *Vatacarus* the endoparasitism recorded is the most complete that has been observed among the Trombidioidea (the skin endoparasites of the family Demodicidae being placed in the Demodicoidea Banks 1894 (nom. emend. Banks pro Desmodicoidea Banks 1894, restricted)).

One further mite may be mentioned here. Ewing (1938) described *Hemitrombicula simplex* as a new genus and species (monotypic) an unusual mite with two unequal tarsal claws; later (1944) he made this genus the type of a subfamily Hemitrombiculinae, placed in the Trombiculidae. This mite was recorded as parasitic within the mouth of a North American snake, *Elaphe*

* According to Reid (1956) *Laticaula* is the only genus of sea-snake which is land-going and probably therefore *Vatacarus* is unlikely to be found in other sea-snakes.

obsoleta obsoletu (Say), where the mite larvae were "attached between the rows of teeth on the upper jaw only"; this was the only record for this mite. In 1947 Wharton rejected the genus from the Trombiculidae, but did not re-assign it as Lawrence (1949) pointed out, and such only occurred in 1952, when Baker and Wharton (*loc. cit.*) synonymised *Hemitrombicula* with *Limnochares* Latreille 1796. These latter authors made no comment on the parasitization of the snake by the larval mite, which must be very unusual for a *Limnochares*. The synonymy proposed should be confirmed by a redescription of Ewing's *H. simplex*.

Ipomorphy and Endoparasitism Within the Acarina

The term "ipomorphy" is proposed here to denote a modification of an animal to a worm-like or maggot-like shape, in groups not normally so. The writer is of the opinion that this word will fulfil a definite need, and has not been able to find any existing noun available, from consultation with a number of texts on zoology and parasitology. Reference to the great "Oxford English Dictionary" shows no appropriate noun derived from the Greek roots, *ἵψ* and *σκόληξ*, which appear to be the best to use, nor from the Latin *vermis*. The term *scolex* has now mostly taken on a special meaning in zoology, and the writer favours "ipomorphy" as being in line with current terminology in morphology.

Ipomorphy is seen among various of the Acarina, in groups apparently unrelated. When present, the idiosoma also shows often a degree of annulation. Thus within the endoparasitic Eriophyidae (Tetranychidae, Trombidiformes), which are plant parasites, and the Demodicidae (Demodicoidea, Trombidiformes), as well as the free-living genus *Nematalycus* Strenzke 1954 (Nematalycidae, Trombidiformes), such is the case. Within the Tetranychidae (Trombidiformes) a similar modification has been recorded by Baker (1948) for *Tentipulpus eriophyoides* Baker 1948. Within the Mesostigmata similar ipomorphic forms are seen, e.g. among the Halarachnidae, which are endoparasites of the respiratory passages of mammals, and the Entonyssidae, which utilize a similar biological niche in the land snakes, and the Rhinonyssidae, which use birds similarly. A recently discovered group of mites, the Gastronyssidae (Sarcoptiformes), which are endoparasites of bats, also show ipomorphy. These have been recorded from either the stomach or the nasal fossae of the hosts (Eain 1956).

Generally speaking, the presence of ipomorphy within the Acarina appears to go with the adoption of endoparasitism. There are, however, a number of mites which have made a partial or fairly complete move towards endoparasitism, in which ipomorphic forms have not as yet been observed, e.g. the genus *Riccardoella* (Ereynetidae) and the various Speleognathidae. It would appear that among the Acarina the development of ipomorphy must be considered as a polyphyletic character. Although useful therefore in an ecological classification, it cannot be used as a major systematic character.

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SOME NEMATODES FROM FISH FROM HERON ISLAND, QUEENSLAND

BY *PATRICIA M. MAWSON*

Summary

An unusual larva of *Thynnascaris* sp. is described from *Chaetodon* sp. and *Cattydon* sp.; *Procamallanus* sp. is described from *Sigmanum nebulosus*, and *Metabronema magna* (Taylor) from the swim bladder of *Caranx speciosus*; some variations from the type are recorded in this last species.

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[Read 11 October 1956]

SUMMARY

An unusual larva of *Thynnascaris* sp. is described from *Chaetodon* sp. and *Cattydon* sp.; *Procamallanus* sp. is described from *Signatum nebulosus*, and *Metabronema magna* (Taylor) from the swim bladder of *Caranx speciosus*; some variations from the type are recorded in this last species.

This small collection of nematodes was made at Heron Island, off the Queensland coast, by my colleague, Mr. S. J. Edmonds, while on an excursion with the Zoology Department of the University of Queensland. I am most grateful to him for the opportunity of examining these worms.

Metabronema magna (Taylor)

(Figs 1-3)

Metabronema magna is now recorded from the golden trevally, *Caranx speciosus*. The species is apparently common in the swim bladder of these fish, of which a large number were examined by Mr. Edmonds. About six worms was the usual number present in each fish. The description agrees generally with that given by Taylor (1925, pp. 60-66) and although there are slight variations it seems certain that the same species is present.

The longest female is 100 mm., the longest male 35 mm. The shortest female, about 15 mm. long and without eggs, is in copula with a male of about 30 mm.

Taylor describes broken longitudinal striations on the cuticle of the female. In those from the trevally, the cuticle anterior to the vulva is transversely striated, and posterior to it the longitudinally elongated bosses appear; in older females these are further ornamented with smaller ridges, almost resembling fingerprints. The wide lateral alae commence at the level of the base of the oesophagus and continue past the anus; for most of their length they bear oblique as well as transverse striae.

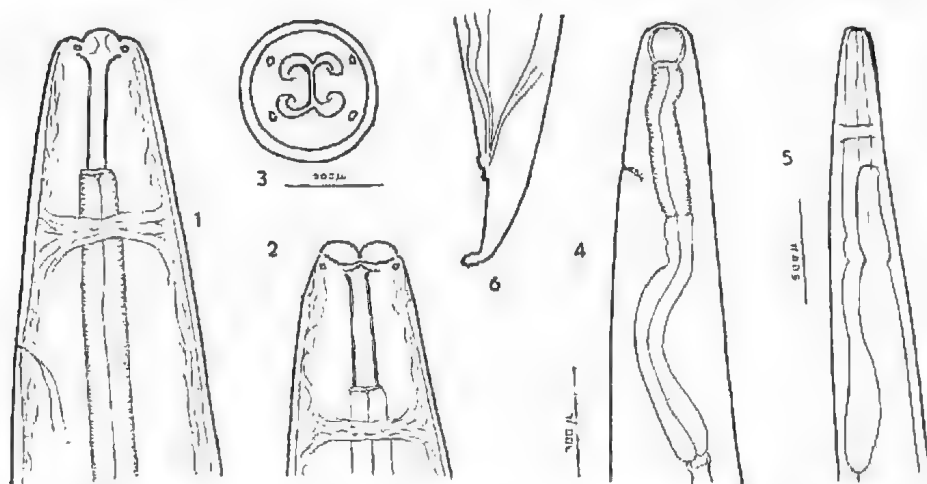
In en face view only the two pairs of sublateral papillae described by Taylor were seen; in dorsal (and ventral) view, a very small lateral papilla can be seen on each side, with a minute amphidial opening anterior to it (Fig. 2).

The vestibule is rather shorter than the type, especially in the male; it is 440μ by 60μ in the female, 290μ by 40μ in the male. The cervical papillae, nerve ring, and excretory pore are as described by Taylor, lying, in a young female in which the vestibule is 400μ long, 160μ , 510μ , and 850μ , respectively, from the anterior end of the worm.

The tail of a large female specimen is 460μ long, very different from the 100-210 μ given by Taylor. The vulva is marked by well-developed muscular lips as described by Taylor; these lie lateral to one another, with a deep S-shaped groove between them. The eggs are 39-41 μ by 20-22 μ , and contain each a coiled larva.

* University of Adelaide.

In the male the shape of the spicules is exactly as described by Taylor; the length of the longer is 1.6-1.7 mm., and of the shorter 0.5-0.6 mm. (1.7-1.8 mm. and 0.39-0.45 mm. in the original description). In the copulating male it is the shorter spicule which has entered the female. No gubernaculum was seen, although it was described in the type. The male tail is 500 μ long (270-310 μ in type). The number and arrangement of the caudal papillae is similar in both collections.



Figs. 1-3.—*Metabronema magna*, lateral, dorsal and en face views of head; Fig. 4.—*Procamallanus* sp. anterior end. Figs. 5-6.—*Thynnascaris* sp., 5, anterior end; 6, tail of male larva. Figs. 1, 2, 3, 4 and 6 all to same scale.

Procamallanus sp.

(Fig. 4)

Several female worms belonging to the genus *Procamallanus* were taken from the black-spined bream, *Siganum nebulosus*. The species is close to *P. sphacroconchus* Törnquist in which the tip of the tail is, however, bifid and in which the buccal capsule is more elongate, and to *P. sigani* Yamaguti. The vulva is further forward in the Australian species than in either of these. In the absence of males no specific determination has been made.

The worms are up to 19 mm. long. The buccal capsule is nearly as wide as long, without spiral thickenings or other ornamentation, the base 120 μ from the anterior end, and the equatorial diameter 110 μ , including the 15 μ thick walls. The anterior muscular part of the oesophagus is 430 μ long, the posterior part 750 μ . The excretory pore is 400 μ from the anterior end. The tail is 280 μ long, conical, and directed dorsad, and it ends in a simple rounded tip.

The region around the vulva is strongly chitinated, but does not project noticeably; it lies at about the end of the first third of the body length, 5.3 mm. from the head in a specimen 15.3 mm. long. No shelled eggs were seen; the uteri contain a coiled slender-tailed larva, about 450 μ long.

Thynnascaris sp.

(Figs. 5-6)

Larval worms, all of which appear very similar, were taken from the tusk fish, *Chaetodon* sp., and from *Callydon* sp. They are ascarids, with three low lips, short oesophagus, with small ventriculus, and long appendix and short intestinal caecum. The tail is conical with short digitiform tip without spines. They

have been assigned to the genus *Thynnascaris* because of the presence of a ventriculus. A gonad is present as a well-developed tube in two specimens, and in one of them is obviously a testis, leading back to the anus; in this specimen there is structure lying dorsal to both reproductive duct and rectum, which is presumably the anlage of the spicules (Fig. 8). The worms were recorded as from the intestine, but might have been on the outer wall; with them is the larval stage of a Trypanorhynch cestode. The nematodes are enclosed in a loose outer sheath within which are dark granular masses. It is presumably a 3rd stage larva. as 4th stage in this group show distinct lips and interlabia and a spinous tail.

The developmental stages of *Contracaecum* spp. and *Thynnascaris* spp. larvae in the 2nd intermediate host, and their enclosure in a cyst containing much granular matter, has been described by Johnston and Mawson (1945, p. 126).

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A NEW BLENNY (TRIPTERYGIIDAE) AND PIPEFISH (SYNGNATHIDAE) FROM KANGAROO ISLAND, SOUTH AUSTRALIA

BY T. D. SCOTT

Summary

A new genus and species of Blenny, *Brachynectes fasciatus*, and a new species of Pipefish, *Corythoichthys flindersi* are described and figured. A key is given to the genera of the Tripterygiidae of Australia.

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by T. D. Scott*

[Read 11 October 1956]

SUMMARY

A new genus and species of Blenny, *Brachynectes fasciatus*, and a new species of Pipefish, *Corythoichthys flindersi* are described and figured. A key is given to the genera of the Tripterygiidae of Australia.

INTRODUCTION

During the past few years, the Museum has received several excellent collections of shallow water, weed-living fishes from Pelican Lagoon, Kangaroo Island, South Australia. The collections were made by Mr. H. M. Cooper, Assistant Anthropologist at the South Australian Museum.

A small mesh net was towed over the weedy bottom, in approximately two fathoms of water. In all, five collections were made during different periods of the year, resulting in a comprehensive sampling of the area.

Family TRIPTERYGIIDAE.

A group of blennies with three dorsal fins and moderate to large scales.

KEY TO THE GENERA OF THE TRIPTERYGIIDAE OF AUSTRALIA.

1. Lateral line single	2
Lateral line of two parts	3
2. Lateral line continued to caudal peduncle	<i>Lepidoblennius</i>
Lateral line ending in middle of side	<i>Helcogramma</i>
3. Head scaly	<i>Gillias</i>
Head naked	4
4. Second dorsal shorter than third dorsal	<i>Brachynectes</i> gen. nov.
Second dorsal longer than third dorsal	5
5. No scales between lateral line and back	<i>Notoclinops</i>
Several rows of scales between lateral line and back	6
6. Mouth large, reaching posterior border of eye	<i>Verconectes</i>
Mouth smaller, reaching anterior half of eye	7
7. Dorsal fins close together; no produced rays	<i>Vauclusella</i>
Dorsal fins more separated; some rays produced	<i>Tripterygion</i>

BRACHYNECTES gen. nov.

Body short, not much compressed. Covered with ctenoid scales of moderate size, extending on to the breast and belly. Head naked with numerous pores. Lateral line of two parts, the first short, formed of simple tubes, and separated by two rows of scales from the second, consisting of incised scales. Three dorsal fins, close together, the number of spines in the second less numerous than the number of rays of the third. Mouth large, extending to hind border of

* South Australian Museum.

eye. Patches of villiform teeth in both jaws, becoming narrow laterally. No enlarged teeth. Vomer with patches of similar teeth. No teeth on palatines. Pectoral rays all simple. Ventrals of two simple rays. Caudal rounded.

Separated from other Australian genera in having the second dorsal fin shorter than the third.

Brachynectes fasciatus sp. nov.

D.iii.x.13 P.12 A.20-21 V.2 C.13 Br.6

Lat. line 10 + 21. Lat. trans. 2 : 7.

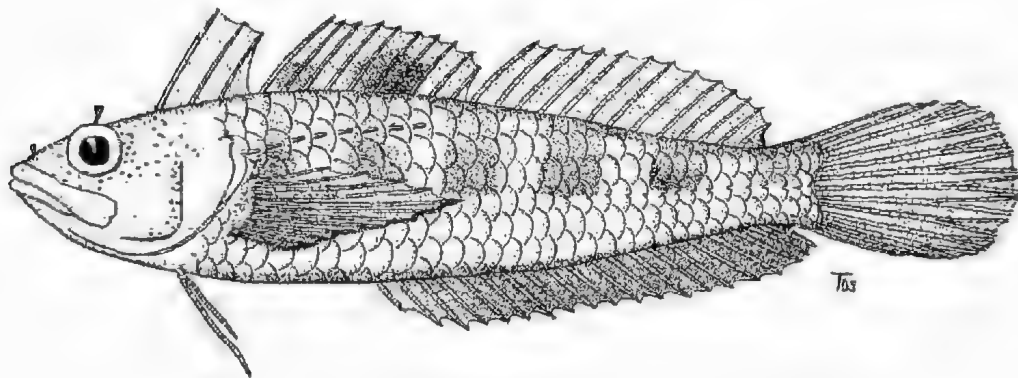


Fig. 1

Head length 12 mm. (3.9), body depth 10 (4.7), body width 8 (5.8) in the total length 47 mm. Snout 3 (4.0), eye 3 (4.0) in the head. Interorbital space less than eye. First dorsal spine the longest, length 5 mm., spines decreasing in size posteriorly.

Head large, naked. Several rows of pores below and behind the eye, across the nape, and on the preopercular margin. Anterior nostrils with a simple tentacle. A broader supra-orbital tentacle. Lips thick, mouth oblique, maxillary extending to hind-border of eye. A broad band of villiform teeth anteriorly in each jaw, narrowing laterally. No enlarged teeth. Similar teeth in patches on the vomer. Palatines toothless.

Gill membranes united, free from isthmus. Upper opercular margin incised. Scales ctenoid, moderate. Lateral line of two parts, a short upper part with simple tubes, ending below the seventh spine of the second dorsal fin, and a longer inferior part, consisting of incised scales. Two rows of scales between the two lateral lines. Thirty rows of scales between the shoulder and the caudal fin.

Dorsal fins close together, but not connected at their bases. Second dorsal shorter than the third. First dorsal commencing over hind margin of preoperculum. Pectoral long, reaching to end of second dorsal fin. All rays simple, the middle ones produced. Ventrals inserted below the preopercular hind margin. Caudal rounded, length 10 mm., none of the rays bifurcate.

Colours (in spirit): Head and body fawn. Body with five to six dark bars, extending down to the row of incised scales. Dorsal fins lightly spotted with black. Two black ocelli on the second dorsal. Anal fin dusky, the border white. Described from a specimen measuring 47 mm. total length, taken August, 1956, in Pelican Lagoon, Kangaroo Island, South Australia. Type in South Australian Museum, Reg. No. F.2921.

Material Examined: 31 specimens, range in length 29 mm. to 54 mm.

Family SYNGNATHIDAE.

Genus *CORYTHOICHTHYS* Kaup.

Corythoichthys Kaup, 1853, p. 231.

Whitley, 1948 (b), p. 268, designates *Syngnathus fasciatus* Gray, 1830 (non Risso), as genotype.

Corythoichthys flindersi sp. nov.

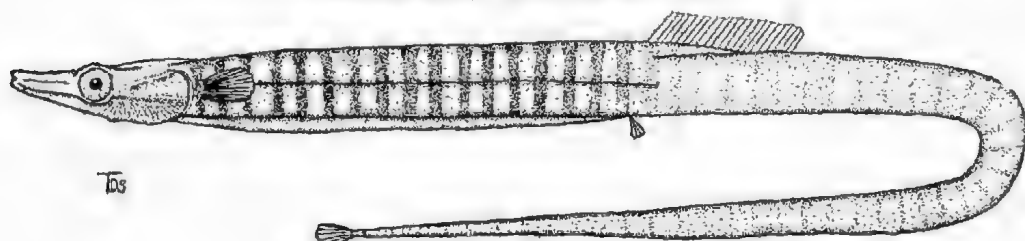


Fig. 2

D.21 C.6 P.12 A.4.

Rings 15-40. Female, no brood pouch.

Head 10 mm. (3.0) in the trunk and (9.1) in the total length 91 mm. Eye 2 (5.0), snout 4 (2.5) in the head. Trunk 30 (2.0) in the caudal. Body depth 4.5 (20), body width 3.2 (28) in the total length.

Snout rather short, almost equal to the postorbital part of the head. Operculum with two distinct keels, which join immediately behind the eye. Head with a sharp median ridge extending from the tip of the snout to the anterior interorbital region. A similar median ridge extending from the hind border of the eye on to the first body ring. Supraorbital ridges sharp, not quite reaching the dorsal body ridges. A distinct lateral ridge from the angle of the mouth, ending below the eye.

Trunk with 7 angles, caudal with 4. Lateral trunk ridges not continuous with upper tail ridges. Lower lateral ridges continuous. Pectoral fin small, length 2 mm. Dorsal fin short, length from origin to insertion 7 mm. Anal fin minute, with 4 rays. Caudal fin small, length 2 mm.

Colours: Body light fawn. Brown bands on the trunk, a bright blue spot at the top of each band, the space between these spots orange coloured. A small white spot on the edge of the ventral keel between the brown bands, marking the separate body rings. Ventral surface yellow to vent, white posteriorly. Head brown, with two white stripes on the cheeks, joining below. Snout yellow below, reddish above.

Type in South Australian Museum, Reg. No. F.2922.

Affinities: Similar to *C. vercoi* (Waite and Hale, 1921, p. 198), but separated by possessing 4 anal rays, absence of ridge from snout to first nostril, two ridges on operculum and differing in the colour pattern.

Material Examined: Two specimens measuring 91 mm. and 94 mm. total length.

Named after Captain Matthew Flinders, R.N., who discovered and named Pelican Lagoon on April 4th, 1802.

Three species of the genus *Corythoichthys* are now recognised from South Australia, and may be separated as follows:

- | | |
|--|------------------|
| 1. Length of snout equal to half length of head | <i>phillipi</i> |
| Length of snout less than half length of head | 2 |
| 2. Two opercular ridges; 4 anal rays; no ridge from snout to first nostril | <i>flindersi</i> |
| One opercular ridge; 2 anal rays; a ridge from snout to first nostril | <i>vercoi</i> |

A further species, *Parasyngnathus poecilolaemus* (Peters, 1869), which was placed previously in the genus *Corythoichthys* by McCulloch (1929), has now been included in the genus *Parasyngnathus* by Whitley (1948, a).

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ABSTRACTS OF EXHIBITS AND LECTURES AT MEETING OF THE SOCIETY DURING 1956

Summary

**ABSTRACTS OF EXHIBITS AND LECTURES AT MEETINGS OF THE
SOCIETY DURING 1956.**

April 12—J. THOMAS: Illustrated talk on "Growth problems associated with *Pinus radiata*".

I. M. THOMAS exhibited a living specimen of fresh-water medusa, *Craspedacusta sowerbii* and explained its life-cycle.

May 10—I. M. THOMAS, deputizing for Sir Douglas Mawson, discussed the programme for the International Geophysical Year.

S. B. DICKENSON: Illustrated talk on "The outlook for uranium".

June 11—PROF. L. G. H. HUXLEY: A talk on "Current research problems of the Physics Department of the University of Adelaide".

July 12—H. G. ANDREWARTHA: A talk on "Current problems in animal ecology".

Aug. 9—PROF. E. A. RUDD: A talk on "The current Australian search for oil".

Sept. 13—F. W. MOORHOUSE: A talk on "The fishing industry in South Australia".

Oct. 11—C. G. STEPHENS: Presidential address, "The phenology of Australian Soils".

Nov. 8—H. B. S. WOMERSLEY: Illustrated talk on "The uses of seaweed".

I. M. THOMAS exhibited some new Australian *Enteropneusta*.

BALANCE SHEET

Summary

Receipts and Payments for year ended 30th September, 1956.

£4,718 10 6

Receipts and Payments for year ended 30th September, 1956.

£6,275 17 8

H. M. HALE, Hon. Treasurer.

Adelaide, 11th October, 1956.

**AWARDS OF THE SIR JOSEPH VERCO MEDAL AND LIST OF FELLOWS,
MEMBERS, ETC., 1956**

Summary

AWARDS OF THE SIR JOSEPH VERCO MEDAL.

1929	PROF. WALTER HOWCHIN, F.G.S.
1930	JOHN MCC. BLAKE, A.L.S.
1931	PROF. SIR DOUGLAS MAWSON, O.B.E., D.Sc., B.E., F.R.S.
1933	PROF. J. BURTON CLELAND, M.D.
1935	PROF. T. HARVEY JOHNSTON, M.A., D.Sc.
1938	PROF. J. A. PRESCOTT, D.Sc., F.A.C.I.
1943	HERBERT WOMERSLEY, A.L.S., F.R.E.S.
1944	PROF. J. G. WOOD, D.Sc., Ph.D.
1945	CECIL T. MADIGAN, M.A., B.E., D.Sc., F.G.S.
1946	HERBERT M. HALE, O.B.E.
1955	L. KEITH WARD, I.S.O., B.A., B.E., D.Sc.
1956	N. B. TINDALE, B.Sc.

LIST OF FELLOWS, MEMBERS, ETC.

AS AT 30th SEPTEMBER, 1950.

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions. Those marked with a dagger (†) are Life Members.

Any change in address or any other changes should be notified to the Secretary.

Note—The publications of the Society are not sent to those members whose subscriptions are in arrear.

Date of
Election

HONORARY FELLOWS

1949.	*CLELAND, PROF. J. B., M.D., Dashwood Road, Beaumont, S.A.—Fellow, 1895-1949; <i>Verco Medal</i> , 1933; <i>Council</i> , 1921-26, 1932-37; <i>President</i> , 1927-28, 1940-41; <i>Vice-President</i> , 1926-27, 1941-42.
1955.	*MAWSON, PROF. SIR DOUGLAS, O.B.E., D.Sc., B.E., F.R.S., University of Adelaide— <i>Verco Medal</i> , 1931; <i>President</i> , 1924-25, 1944-45; <i>Vice-President</i> , 1923-24, 1925-26; <i>Council</i> , 1941-43.
1955.	*OSBORN, PROF. T. G. B., D.Sc., 22 Hardwicke Street, Balwyn, Victoria— <i>Council</i> , 1915-20, 1922-24; <i>President</i> , 1925-26; <i>Vice-President</i> , 1924-25, 1926-27.
1955.	*WARD, L. K., I.S.O., B.A., B.E., D.Sc., 22 Northumberland Street, Heathpool, Marratville, S.A.— <i>Council</i> , 1924-27, 1933-35; <i>Vice-President</i> , 1927-28; <i>President</i> , 1928-30.

FELLOWS

1946.	ABBIE, PROF. A. A., M.D., D.Sc., Ph.D., University of Adelaide.
1953.	ADCOCK, MISS A., 4 Gertrude Street, Norwood, S.A.
1951.	ARCHERSON, G. D., B.E., Civil Engineering Department, University of Melbourne, Carlton, Victoria.
1927.	*ALDERMAN, PROF. A. R., Ph.D., D.Sc., F.C.S., University of Adelaide— <i>Council</i> , 1937-42, 1954-55, 1955-56.
1951.	ANDERSON, MRS. S. H., B.Sc., Zoology Dept., University of Adelaide, S.A.
1951.	ANDREWS, J., M.B., B.S., 40 Seafeld Avenue, Kingswood, S.A.
1935.	*ANDREWARTHA, H. G., M.Ag.Sc., D.Sc., Zoology Dept., University of Adelaide— <i>Council</i> , 1949-50; <i>Vice-President</i> , 1950-51, 1952-53; <i>President</i> , 1951-52.
1935.	*ANDREWARTHA, MRS. H. V., B.Agr.Sc., M.Sc. (nec H. V. Steele), 29 Claremont Avenue, Netherby, S.A.
1929.	*ANGEL, F. M., 34 Fullarton Road, Parkside, S.A.
1939.	*ANGEL, MISS L. M., M.Sc., c/o Mrs. C. Angel, 2 Moore Street, Toorak, Adelaide, S.A.
1945.	*BARTLETT, H. K., L.Th., 2 Abbotshall Road, Lower Mitcham, S.A.
1950.	BEASLEY, A. K., Harris Street, Marden, S.A.
1950.	BECK, R. G., B.Agr.Sc., R.D.A., Lynewood Park, Mil-Lel, via Mount Gambier, S.A.
1932.	BECC, P. R., D.D.Sc., L.D.S., Shell House, 170 North Terrace, Adelaide.
1928.	BEST, R. J., D.Sc., F.A.C.I., Waite Institute (Private Mail Bag), Adelaide.
1956.	BLACK, A. B., A.S.A.S.M., M.I.M.M., 36 Woodcroft Avenue, St. Georges, S.A.
1934.	BLACK, E. C., M.B., B.S., Magill Road, Tranmere, Adelaide.
1950.	BONNIN, N. J., M.B., B.S., F.R.C.S. (Eng.), F.R.A.C.S., 40 Barnard Street, North Adelaide, S.A.
1945.	†*BONYTHON, C. W., B.Sc., A.A.C.I., Romalo House, Romalo Avenue, Magill, S.A.
1940.	BONYTHON, SIR J. LAVINGTON, 263 East Terrace, Adelaide.
1945.	*BOONSMMA, C. D., M.Sc., B.Sc.For., 6 Celtic Avenue, South Road Park, S.A.
1917.	*BOWES, D. R., Ph.D., M.Sc., D.I.C., F.G.S., Geology Department, The University, Glasgow, Scotland.

- Date of Election
1939. BROOKMAN, MRS. R. D. (nee A. Harvey), B.A., Meadows, S.A.
1944. *BLUNDICE, Miss N. T., M.Sc., C.S.I.R.O., Div. Plant Industry, P.O. Box 109, Canberra, A.C.T.
1925. BURDON, H. S., D.Sc., University of Adelaide—Council, 1946-47, 1947-48, 1948-49.
1922. *CAMPBELL, PROF. T. D., D.D.Sc., D.Sc., Dental Dept., Adelaide Hospital, Adelaide—Council, 1928-32, 1935, 1942-45; *Vice-President*, 1932-34; *President*, 1934-35.
1953. CARTER, A. N., B.Sc., 70 Madeline Street, Burwood, E.13, Victoria.
1929. CHRISTIE, W., M.B., B.S., 7 Walter Street, Hyde Park, Adelaide, S.A.—*Treasurer*, 1933-38.
1955. CLOUTIER, E. A., c/o Department of Mines, Adelaide, S.A.
1949. COLLIVER, F. S., Geology Department, University of Queensland.
1929. *COTTON, B. C., S.A. Museum, Adelaide—Council, 1943-46, 1948-49; *Vice-President*, 1949-50, 1951; *President*, 1950-51.
1950. CRAWFORD, A. R., B.Sc., Dept. of Mines, Adelaide.
1956. DAILEY, B., Ph.D., S.A. Museum.
1953. DANE, D. M. S., M.B., B.Chic., M.R.C.S., L.R.C.P., B.A., Institute of Medical and Veterinary Science, Promo Road, Adelaide.
1951. DAVIDSON, A. C. L., Ph.D., B.Sc., c/o Burns Philp Trust Co., 7 Bridge Street, Sydney, N.S.W.
1950. DELAND, C. M., M.B., B.S., D.P.H., D.T.M., 29 Gilbert Street, Goodwood, S.A.—Council, 1949-51, 1954-57; *Vice-President*, 1951-52, 1953-54; *President*, 1952-53.
1941. DICKINSON, S. B., M.Sc., c/o Department of Mines, 31 Flinders Street, Adelaide, S.A.—Council, 1949-51, 1954-56; *Vice-President*, 1951-52, 1953-54; *President*, 1952-53.
1930. DIX, E. V., Hospitals Department, Rundle Street, Adelaide, S.A.
1944. DUNSTON, S. M. L., M.B., B.S., 170 Payneham Road, St. Peters, Adelaide.
1931. DWYER, J. M., M.B., B.S., 105 Port Road, Hindmarsh, S.A.
1933. *EARDLEY, Miss C. M., M.Sc., University of Adelaide—Council, 1943-46.
1945. *EDMONDS, S. J., B.A., M.Sc., Zoology Department, University of Adelaide—Council, 1954-55; *Programme Secretary*, 1955-56; *Secretary*, 1956-57.
1902. *EDQUIST, A. G., 19 Farrell Street, Glenelg, S.A.—Council, 1949-1953.
1936. EICHLER, H., *Dier. nat.*, Botanic Gardens, Adelaide.
1927. *FINLAYSON, H. H., 305 Ward Street, North Adelaide—Council, 1937-40.
1951. FISHER, R. H., 265 Goodwood Road, Kings Park, S.A.
1923. *FRY, H. K., D.S.O., M.D., B.S., B.Sc., F.R.A.C.P., Town Hall, Adelaide—Council, 1933-37; *Vice-President*, 1937-38, 1939-40; *President*, 1938-39.
1955. GILES, E. T. (Dc.), Ph.D., M.Sc., D.I.C., S.A. Museum, North Terrace, Adelaide.
1954. GIBSON, A. A., A.W.A.S.M., Geologist, Mines Department, Adelaide.
1953. *GLAESSNER, M. F., D.Sc., c/o Geology Department, University of Adelaide—Council, 1952-54.
1927. GODFREY, F. K., Box 951 H, G.P.O., Adelaide.
1935. GOLDSACK, H., Coromandel Valley, S.A.
1951. GREEN, J. W., 6 Bedford Avenue, Subiaco, West Australia.
1904. GRIFFITH, H. D., 13 Dunrobin Road, Brighton, S.A.
1948. GROSS, G. F., M.Sc., South Australian Museum, Adelaide—*Secretary*, 1950-53.
1914. GUPPY, D. J., B.Sc., c/o W.A. Petroleum Co., 251 Adelaide Terrace, Perth, W.A.
1922. *HALE, H. M., O.B.E., c/o S.A. Museum—*Vice Modus*, 1946; *Council*, 1931-34, 1950-53, 1956-57; *Vice-President*, 1934-36, 1937-38; *President*, 1936-37; *Treasurer*, 1938-50, 1953-56.
1949. HALL, D. R., Tea Tree Gully, S.A.
1930. †HANCOCK, N. L., 3 Bewdley, 66 Beresford Road, Ross Bay, N.S.W.
1953. *HANSEN, I. V., B.A., 34 Herbert Road, West Croydon, S.A.
1946. *HARDY, MRS. J. E. (nee A. C. Beckwith), M.Sc., Box 62, Smithton, Tas.
1944. HARRIS, J. R., B.Sc., c/o Waite Institute (Private Mail Bag), Adelaide.
1944. HERMIST, R. I., B.Agr.Sc., 49 Halsbury Avenue, Kingswood, S.A.
1954. HILTON, F. M., B.Agr.Sc., 17 Kay Avenue, Berri, S.A.
1951. HOCKING, L. J., The School, Scott's Creek, S.A.
1924. *HOSSFELD, P. S., Ph.D., 132 Fisher Street, Fullarton, S.A.
1944. HUMBLE, D. S. W., M.P.S., J.P., 238 Payneham Road, Payneham, S.A.
1917. HUTTON, J. T., B.Sc., 18 Emily Avenue, Clapham.
1928. IFOULD, P., 14 Wyatt Road, Burnside, S.A.
1945. *JESSUP, R. W., M.Sc., c/o C.S.I.R.O., Canberra, A.C.T.
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1951. *SCOTT, T. D., M.Sc., S.A. Museum, North Terrace, Adelaide, S.A.—*Programme Secretary*, 1953-54, 1956-57.
1924. *SEGUIT, R. W., M.A., B.Sc., Engineering and Water Supply Department, Victoria Square, Adelaide—*Secretary*, 1930-35; *Council*, 1937-38; *Vice-President*, 1938-39, 1940-41; *President*, 1939-40.
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 1929. *TAYLOR, J. K., B.A., M.Sc., Waite Institute (Private Mail Bag), Adelaide - *Council*,
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Vice-President, 1944-45; *Rep. Fauna and Flora Protection Committee*, 1945;
Treasurer, 1950-51, 1956-57.
 1954. *WOMERSLEY, H. B. S., Ph.D., Botany Department, University of Adelaide.
 1941. WOMERSLEY, J. S., B.Sc., Lac, New Guinea.
 1923. *WOOD, PROF. J. G., D.Sc., Ph.D., Botany Department, University of Adelaide - *Vercò*
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